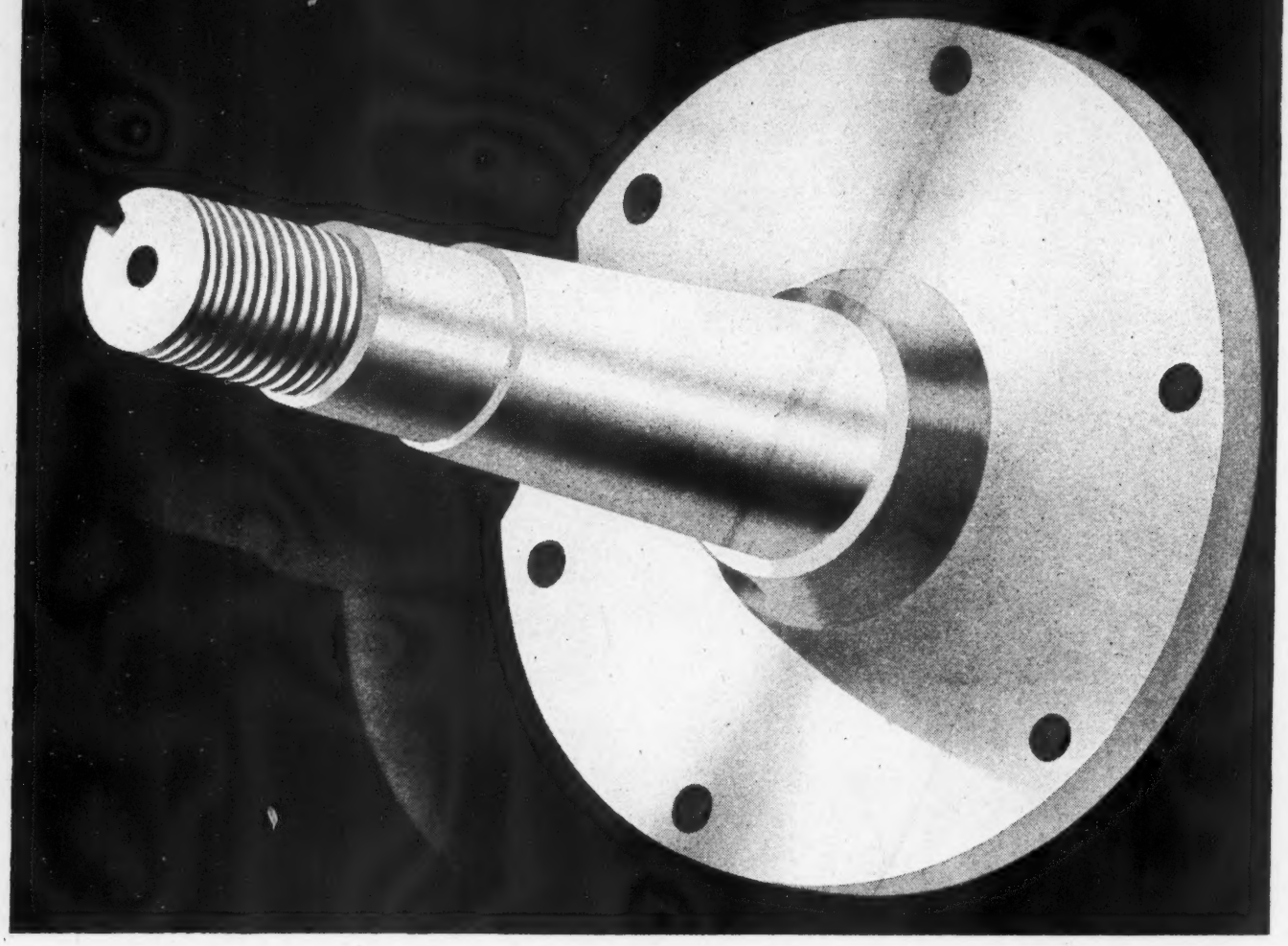
# THE TECH ENGINEERING NEWS

MASSACHUSETTS

TOBER, 1945
WEN[illegible]IVE CENTS

**Molybdenum is an economical preventive of temper brittleness in steel.**



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

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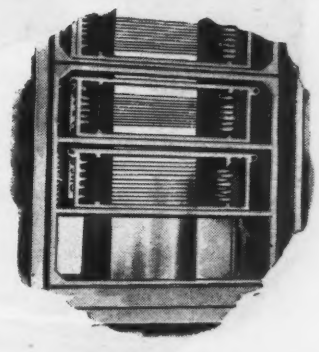
MOLY

# he started something that will never stop

**25 YEARS AGO** a Westinghouse research engineer started something that was destined to have a profound effect upon the lives of all of us . . . and upon generations yet unborn.
That *something* was radio *broadcasting*.

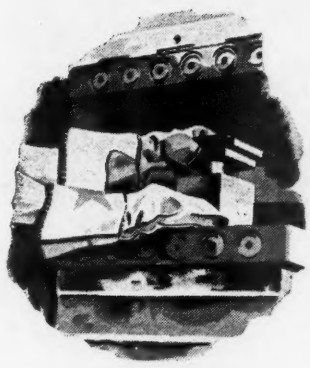
## Radio broadcasting was born

on November 2, 1920, when the Presidential Election returns were broadcast from the tiny radio station, KDKA—built by Dr. Frank Conrad at the Westinghouse plant in East Pittsburgh, Pa. It was the first *scheduled radio broadcast* in history . . . the forerunner of a world-wide network that would eventually carry enlightenment and entertainment to the far corners of the earth.



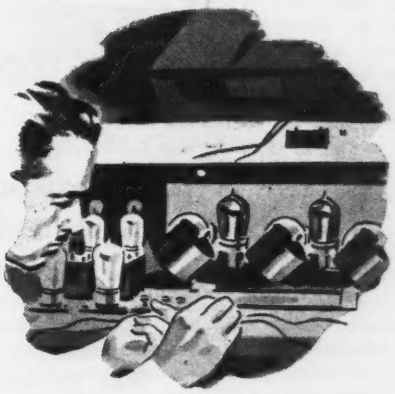
## Another "first"

by Westinghouse was the use of radio waves to fuse a mirror-like finish on dull electrolytic tin plate. High-frequency induction heating now helps make *one pound* of war-scarce tin do the work of *three*.



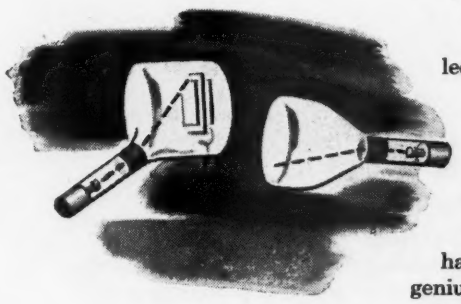
## Dielectric death

. . . administered to weevils in grain elevators . . . is another example of the ingenuity of Westinghouse high-frequency engineers. Westinghouse dielectric heating equipment is today speeding the bonding of plywood and curing of plastics and synthetic rubber.



## Frequency modulation

was pioneered by Westinghouse scientists as far back as 1920. At that early time they experimented with high frequencies that led the way to the static-free, crystal-clear FM we know today.



## Television

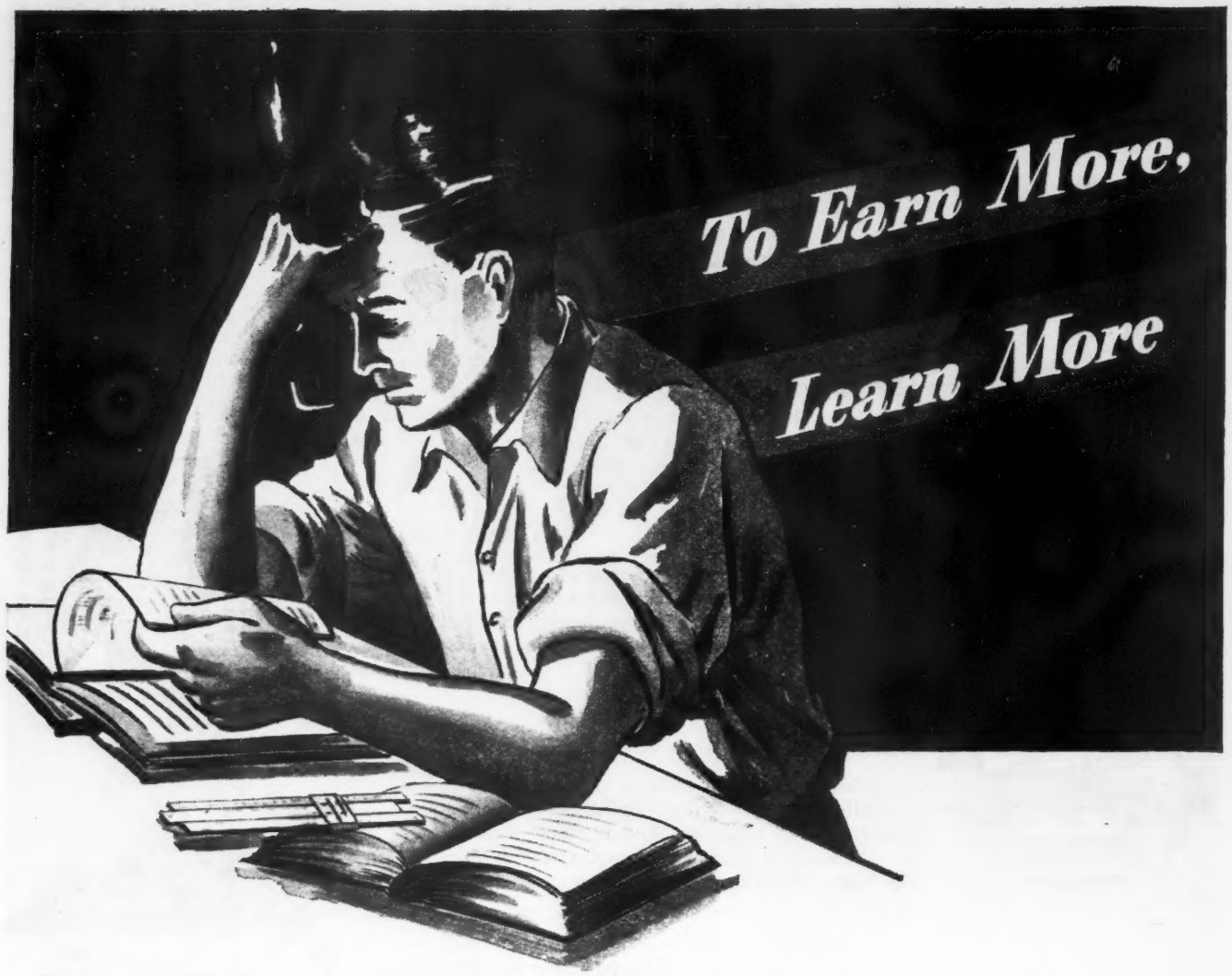
has become a reality because of the genius of Westinghouse micro-wave experts, who developed the forerunner of the Iconoscope in 1923 and the Kinescope in 1929. These devices banished forever cumbersome scanning discs.

## Research in microwaves

never stops at Westinghouse. Research, begun 20 years ago, resulted in the key electronic tube for the *first* long range Radar equipment. Other secret devices, born of war in the Westinghouse Research Laboratories, will contribute to a better, brighter peacetime world.

**Westinghouse**
PLANTS IN 25 CITIES OFFICES EVERYWHERE

*Tune in: JOHN CHARLES THOMAS—Sunday, 2:30 pm, EWT, NBC • TED MALONE—Monday through Friday, 11:45 am, EWT, American Network*




**Be prepared to grasp every opportunity that comes your way after graduation and to make the most of it.**

Have all the answers at your command —including those pertaining to bearings; for bearings figure importantly in every engineering problem wherever wheels and shafts turn.

In fact many an otherwise soundly-designed machine has failed to perform up to expectations because its bearings were not equal to the tasks imposed on them.

A thorough knowledge of Timken Tapered Roller Bearings will enable you to fully satisfy the bearing requirement in almost every kind of machinery and thus avoid troubles due to inadequate bearing equipment.

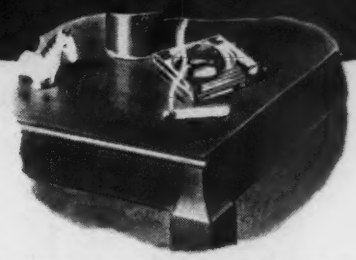
Timken Bearings are the first choice of an overwhelming majority of experienced engineers—and have been for many years. They are as effective in war as in peace. They will carry the loads of reconstruction with a full measure of efficiency, safety and economy. The Timken Roller Bearing Company, Canton 6, Ohio.

# HOW FAMILIAR ARE YOU

## ... with these Familiar things?

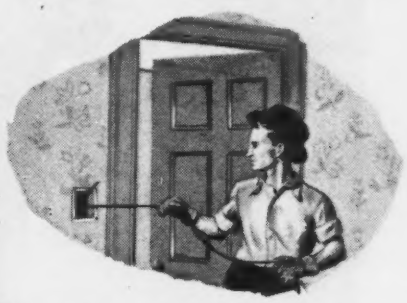
**Q.** **WHAT HAS HAPPENED TO SHOE SOLES THAT YOU SHOULD KNOW ABOUT?**

**A.** Synthetic organic chemistry—to which UCC devotes much of its many-sided research—has made a real contribution to shoe soles. This research has produced, among hundreds of other types, a long-wearing, VINYLITE plastic that is an ideal raw material for soles.



**Q.** **WHY WON'T A LIGHTED CIGARETTE RUIN THIS "WOODEN" TABLE?**

**A.** This table top is made of a new furniture "wood." This material combines wood in all its natural grain and beauty with plastics so that it will resist even the heat of a burning cigarette ... and be remarkably free from mars and stains. Its manufacturer gets plastics as raw materials from a Unit of UCC.



**Q.** **WHAT'S THE BIGGEST NEWS IN ELECTRICAL INSULATION?**

**A.** Out of UCC research have come new flame-resistant insulating materials of plastic that mean added years of carefree service with safety. Out of the same research have come the synthetic organic chemicals *in quantity*, from which plastics are made for a profusion of useful things to make a better world for you.



**Q.** **CAN A DASHBOARD GIVE A HINT?**

**A.** Beauty and utility contributed by plastics to molded dashboards for postwar cars indicate how much has been and can be learned through research. They hint of thousands of improvements which can be achieved in products as plastics come back to peacetime use.

MEN have been able to improve these things because they have been able to improve the raw materials that go into them. The development of a wide range of plastics typifies the progress made with many other raw materials in the 20th Century. UCC contributions to this progress have involved more than a third of the known elements of the earth.

*If you would like more information about plastics, write for a copy of booklet P-10 "A Simplified Guide to* BAKELITE *and* VINYLITE *Plastics."*

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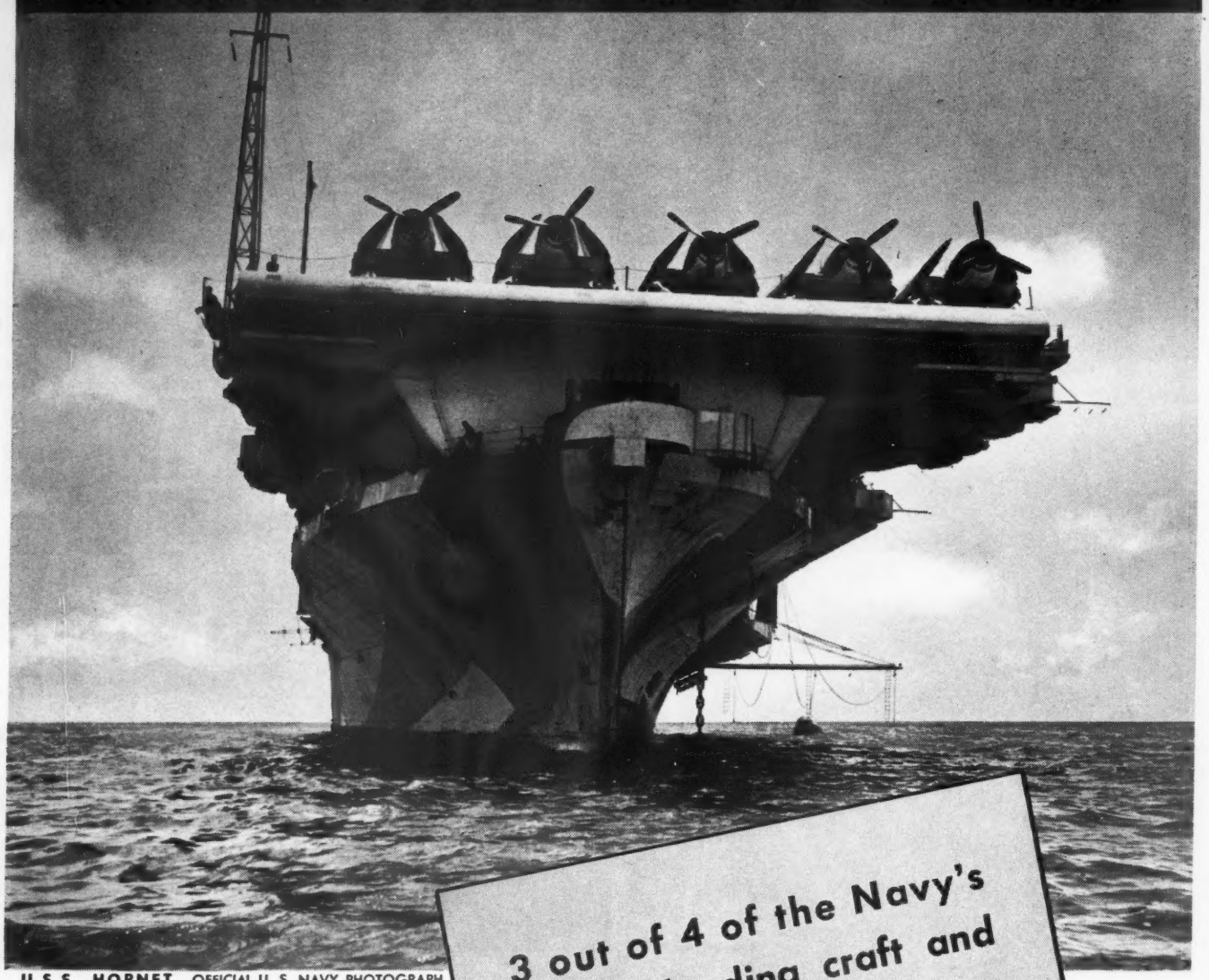
NATIONAL RECEIVERS ARE THE EARS OF THE FLEET



U.S.S. HORNET OFFICIAL U. S. NAVY PHOTOGRAPH

**3 out of 4 of the Navy's ships—landing craft and larger—use receivers designed by National.**

A capital ship is no place to use anything but the finest in radio equipment.

HRO

NC-200

# NATIONAL COMPANY

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NATIONAL RECEIVERS ARE IN SERVICE THROUGHOUT THE WORLD

# THE TECH ENGINEERING NEWS

PROFESSIONAL JOURNAL OF THE UNDERGRADUATES

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Volume XXVII, No. 2

OCTOBER, 1945

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***The 18-foot diameter by 33-foot shell used to insulate atom smashing equipment at the University of Minnesota. It is of welded construction designed to operate at 100 pounds per square inch pressure.***

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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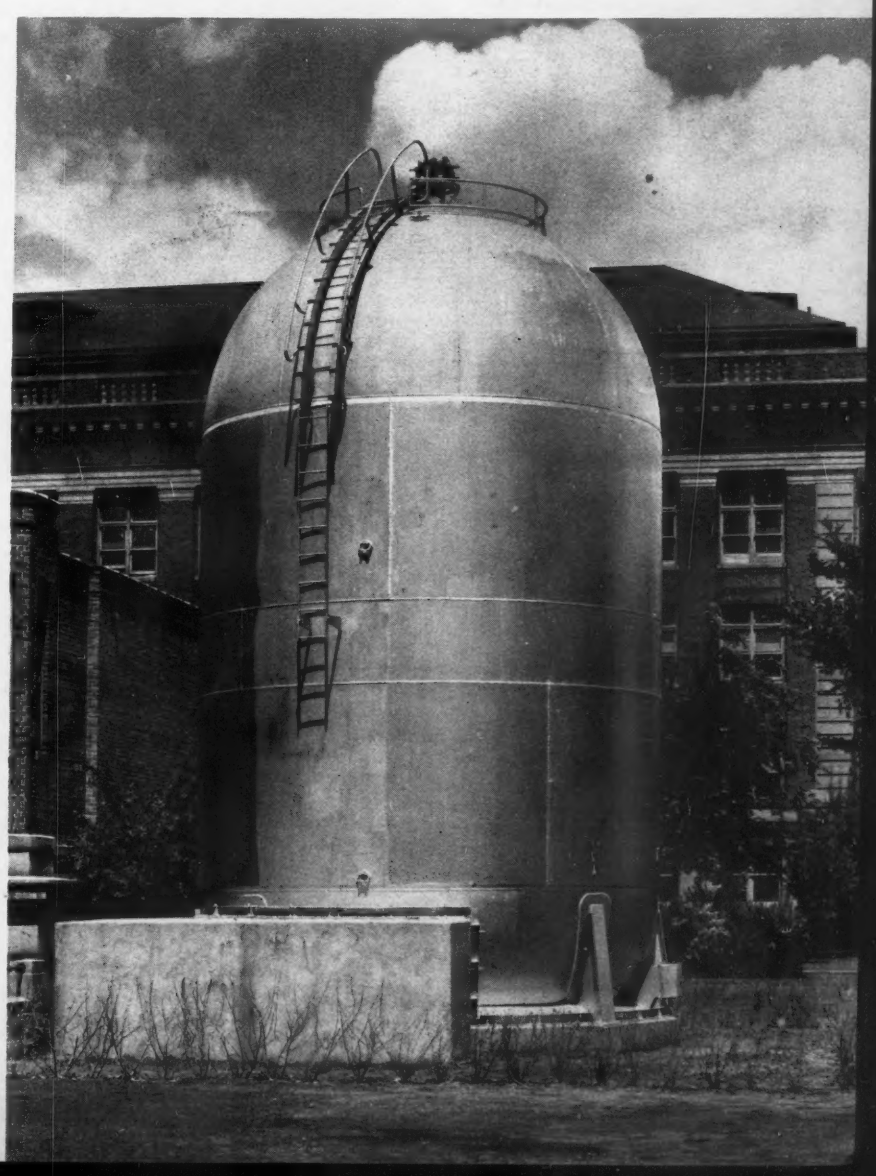


# LIGHT CUT TO ORDER

By F. FAUSTEN MARK, 2-47

*Pictures Courtesy Polaroid Corporation*

FOR centuries man has been able to control light. He has focused it with the lens, changed its direction by the prism, and controlled its properties of color and intensity by various methods. However, there is one property which has been controlled only recently on a large scale. This property is the vibration direction of light. If light is made to vibrate in a single plane only, instead of in many planes as it does ordinarily, it is called polarized light.

The effects of polarization have been noticed by many experimenters. Tourmaline, a semi-precious crystal, may appear opaque to polarized light when viewed in one position, changing to a blue-green color when rotated through ninety degrees. The practical value of such a polarizer is limited because it will transmit only blue-green light of a low intensity.

In 1808 Louis Malus, a Frenchman, observed that calcite cut out glare from window surfaces. As with tourmaline, this observation proved for a time to be important only from an experimental standpoint. These crystals occur in small sizes and are too expensive to be used extensively. The search for a practical polarizer went on.

A Scotchman, Nicol, invented a polarizer which is still used. The Nicol prism is a highly efficient polarizer. Its transmission and polarization are uniform for the entire visible spectrum. However, the use of the prism is limited. It operates well only under certain conditions, and since it is made from calcite its size is necessarily small.

The materials so far mentioned are natural, but in addition to these, synthetic polarizing materials have been found. In 1852 Dr. William Herapath accidentally discovered such a material. He noticed crystals from an evaporated solution of iodine and quinine possessed polarizing ability. These crystals, iodoquinine sulphate or Herapathite, as they were called after their discoverer, were very inexpensive. They transmitted light of all colors with high relative intensity and they were very nearly perfect polarizers. The crystals were very fragile, shattering at the most delicate handling, and they could be obtained in only minute sizes. Nevertheless, they laid the foundation for the construction of modern polarizing materials.

The answer to the production of practical Herapathite polarizing apparatus was found about ten years ago. A process was worked out to construct a material from the crystals in which the crystals would be protected, to keep them from shattering, and in which the crystals would have the same effect as a large crystal.

The solution was found by Mr. Edwin H. Land in the early 1930's. He reasoned that many small crystals over a large area would serve the purpose of a larger crystal. To protect the crystals and to keep them in position after they had been aligned he proposed to bind them in transparent plastic. By using these ideas he obtained a practical artificial polarizer.

His process was essentially to place a solution of the crystals on a sheet of plastic and to stretch the sheet. Due to this stretching, a force was exerted upon the crystals causing them to line up parallel to each other. The plastic was frozen to keep it from resuming its original shape and displacing the crystals. Then the sheet was bonded between transparent protective covering and the material was completed.

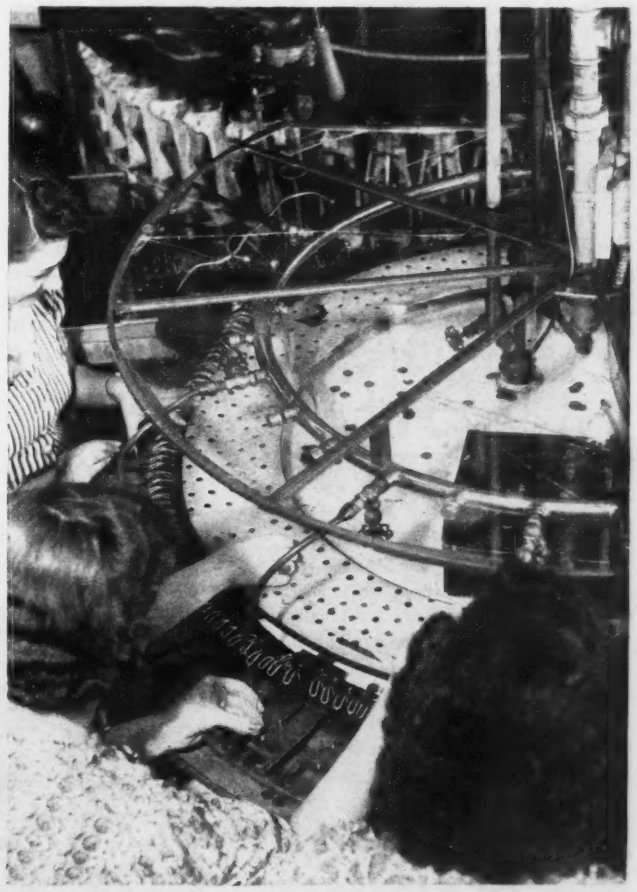
Another polarizing material has been made artificially containing no crystals. Its action is based on the molecular structure of the material. This type forms a clear, haze-free polarizer.

Ordinary light is composed of waves vibrating in every plane. Each light wave vibrates perpendicularly to its direction of propagation. The function of polarizing materials is to absorb these vibrations in all except one plane, thus producing polarized light.

Light polarized in one direction can not pass through a polarizer with a plane of polarization at right angles to the plane of vibration of the light. On the other hand, if both have their planes of polarization parallel, then the light will pass through the polarizer. Use is made of these principles in the construction of polarized light apparatus.

The control of light by polarization is applied in many ways. There are four main uses of polarized

*Producing laminated filters*



*A seaman adjusts the brilliance of his subject with Polaroid sun glasses*

light. They are control of light intensity, the control of reflected light, stereoscopic applications, and the creation and control of color.

Probably the most familiar use of a polarizer is in sunglasses which cut out reflected glare. The glasses operate very simply. Glare light is polarized in a horizontal plane, when reflected from a horizontal surface, and a vertical polarizing lens will block it, for this orientation of the polarizer absorbs light in all but the vertical plane. The light with which we see an object, the diffuse light, is vibrating in all planes so some of it is transmitted. We see the object better, even though not all the diffuse light gets through, because the glare has been removed and the contrast of the scene increased. These glasses are used effectively for all types of reflected glare control.

Polarized illumination may be used to reduce reflected glare from surfaces. Light from an unpolarizing source, when reflected from a surface, is made up of the diffuse light and reflected glare. It is desirable that the reflected glare be stopped. Since the glare comes from horizontal vibrations, light that has been vertically polarized will produce little glare, for the light when reflected will contain not the horizontal glare vibrations which were removed at the source but only diffuse light. It is evident that polarizing lamps are useful in desk work, drafting, etc.

With polarizing filters, control of glare and intensity from automobile headlights can be realized.

The windshield and headlight glass of cars would be polarized with their axes of polarization parallel. If two cars similarly equipped approached each other, the light from the headlights of one would be visible to its driver because this light has been polarized parallel to the axis of the windshield. This light can not be seen except as a dull, purple glow by the driver of the car coming in the opposite direction, because the axis of this car's windshield is perpendicular to the axis of the headlights of the other car.

This control promises to be one of the most important benefits derived from polarized light.

Use is made of polarized light in stereoscopic effects. Pictures and drawings can be projected on a flat surface and made to seem three-dimensional, thus reproducing normal sight.

Two pictures are projected using polarized light. They represent the views seen by each eye. The light of one lies in perpendicular planes with respect to the light of the other. With the aid of a viewer whose lenses' axes are at right angles to one another each eye sees only the image meant for it, and the three-dimensional effect is noticed. This comes about because light from an image can only pass through the lens to the eye which is to receive it.

Another method is used requiring only a single projector instead of the twin projector needed in the apparatus in the preceding section.

The pictures are printed in a polarized layer. This layer is affected by a printing process so that it becomes a partial polarizer of different degrees at different points of the picture.

To see the picture a perfect polarizer must be used whose axis is perpendicular to that of the picture. The fullest contrasts are seen under this condition. The darkness of an area depends upon the degree of polarization of light from this area. Complete polarization shows up as black, lesser degrees being lighter. If the axis of a viewer lens is parallel to the axis of one of the views, then this view will disappear.

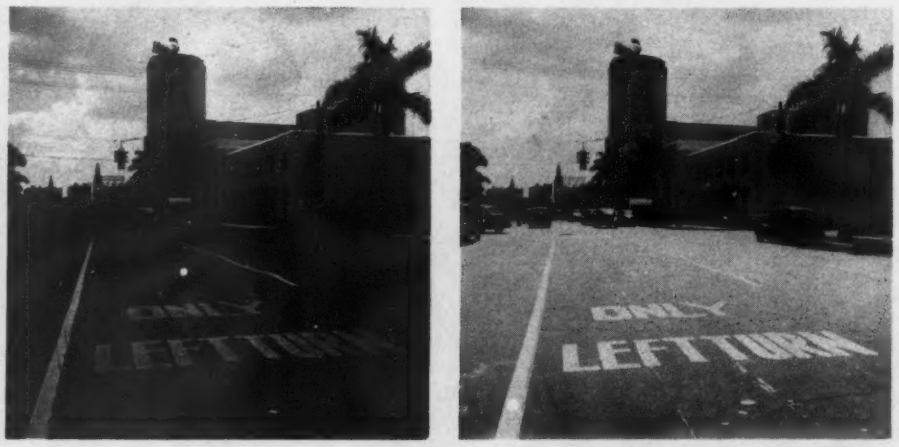
The axis of the right view is perpendicular to that of the left. Viewers similar to ones used in the double projector are needed. Each eye will only see one picture which is made up by the contrasts.

Such a method may be used for topographic maps, photographs, and aids for teaching subjects as solid geometry. The great advantage of the method lies in the fact that bulky complicated apparatus does not have to be employed to achieve a true vision effect.

Polarizing apparatus can be constructed which will create color. If cellophane is placed between polarizing sheets it will take on a variety of colors depending upon the angle between the axes of the polarizers and the thickness of the cellophane. A turn of ninety degrees will give the exact complement of a color.

(*Continued on page 60*)

*Decreased glare for motorists with Polaroid glasses*



# THIS IS M. I. T.

## METEOROLOGY

By H. G. HOUGHTON
Professor of Meteorology

THERE is little doubt that man has been greatly concerned with the weather and its vagaries since he first appeared on this planet. In earlier times foul weather was attributed to the displeasure of the gods and earnest attempts were made to placate them with gifts and sacrifices. In the present enlightened age the blame, but not the gifts, falls on the weather man.

In spite of the importance of the subject, little was done to establish weather forecasting services until quite recent times. Although mariners and farmers had acquired some weather lore, it was not until the telegraph became generally available for the collection of weather data taken at the same time over a large area that it became possible to chart the course of the weather and prepare reliable forecasts. Although a few preliminary efforts were made earlier, the first weather service in the United States was established in 1870 under the Signal Service of the United States Army. The Weather Bureau was established in 1891 and took over the network established by the Signal Service.

As daily weather maps were studied, it became obvious that weather moved in a fairly regular manner so that reasonably satisfactory forecasts could be made by extrapolation coupled with climatological averages and the forecaster's experience with similar situations. Although a number of significant theoretical contributions were made in the nineteenth century, few applications of them were made to forecasting. Few able scientists became interested in the problem so that most of the forecasting was done by persons with little scientific training. However, many empirical results were obtained which have been of great utility.

Starting with World War I, and greatly accelerated by the growth of aviation, there was a demand for more accurate forecasts and for forecasts in the third dimension. This stimulated the theoretical approach and the development of new instruments, led to greater funds for meteorological work, and really represented the starting point of modern meteorology. This renaissance in meteorology started in Norway but rapidly spread to other countries including the United States.

One result of the emergence of meteorology as a science was the need for professional instruction at the college level. The first such training in the United States was offered at M. I. T. when Prof. C. G. Rossby joined the faculty of the Department of Aeronautical Engineering in 1928. In succeeding years the Meteorological Division grew slowly in staff and students. Only graduate degrees were offered in meteorology but some undergraduates in Course IX majored in meteorology. Some time before Pearl Harbor it became apparent to certain farsighted officers of the Army Air Corps that it would be necessary to train hundreds of weather officers to insure the safe operation of the thousands of projected airplanes. This training was started at M. I. T. in the summer of 1940 and rapidly expanded here and at four other institutions. As a result of the increasing importance of meteorology, the Meteorological Division became Course XIV and a separate department on July 1, 1941. In addition to the graduate courses, an undergraduate curriculum leading to the degree of Bachelor of Science in Meteorology has been announced recently.

The atmosphere is a compressible viscous fluid in turbulent motion on a rotating earth. It is the working substance of a thermodynamic machine in which the heat sources and sinks are subject to great variations in time and space. It contains the variable gas water-vapor which changes phase to the liquid and solid states within the usual pressure and temperature ranges, thus releasing large quantities of heat. All of the processes which occur in the atmosphere obey the laws of physics but it has not been possible as yet to solve the problem as a whole and thereby to reduce forecasting to a mathematical science. Because of the importance of scale in atmospheric motions, it is not possible to

(*Continued on page 56*)

*Professor Houghton*

# THE ATOMIC EXPERIMENT

## OFFICIAL UNITED STATES ARMY REPORT

*Editor's Note: This War Department release on the first actual test of atomic power was issued locally in New Mexico soon after the final use of the A-Bomb on Japan brought the experiment to its successful climax and made the official veil of secrecy no longer necessary. Though we have seen various excerpts from this article already in print, apparently the account in its entirety has not yet been widely published; consequently we believe our readers will appreciate our presentation of the complete story of the New Mexico drama.*

MANKIND'S successful transition to a new age, the Atomic Age, was ushered in July 16, 1945, before the eyes of a tense group of renowned scientists and military men gathered in the desertlands of New Mexico to witness the first end results of their $2,000,000,000 effort. Here in a remote section of the Alamogordo Air Base one hundred twenty miles southeast of Albuquerque the first man-made atomic explosion, the outstanding achievement of nuclear science, was achieved at 5.30 a.m. of that day. Darkening heavens pouring forth rain and lightning immediately up to the zero hour heightened the drama.

Mounted on a steel tower, a revolutionary weapon destined to change war as we know it, or which may even be the instrumentality to end all major wars was set off with an impact which signalized man's entrance into a new physical world. Success was greater than the most ambitious estimates. A small amount of matter, the product of a chain of huge specially constructed industrial plants, was made to release the energy of the universe locked up within the atom from the beginning of time. A fabulous achievement had been reached. Speculative theory, barely established in prewar laboratories, had been projected into practicality.

This phase of the Atomic Bomb Project, which is headed by Maj. Gen. Leslie R. Groves, was under the direction of Dr. J. R. Oppenheimer, theoretical physicist of the University of California. He is to be credited with achieving the implementation of atomic energy for military purposes.

Tension before the actual detonation was at a tremendous pitch. Failure was an ever-present possibility. Too great a success, envisioned by some of those present, might have meant an uncontrollable unusable weapon.

Final assembly of the atomic bomb began on the night of July 12 in an old ranch house. As various component assemblies arrived from distant points, tension among the scientists mounted apace. Coolest of all was the man charged with the actual assembly of the vital core, Dr. R. F. Bacher, in normal times a professor at Cornell University.

The entire cost of the project, representing the erection of whole cities and radically new plants spread over many miles of countryside, plus unprecedented experimentation, was represented in the pilot bomb and its parts. Here was the focal point of the venture. No other country in the world had been capable of such an outlay in brains and technical effort.

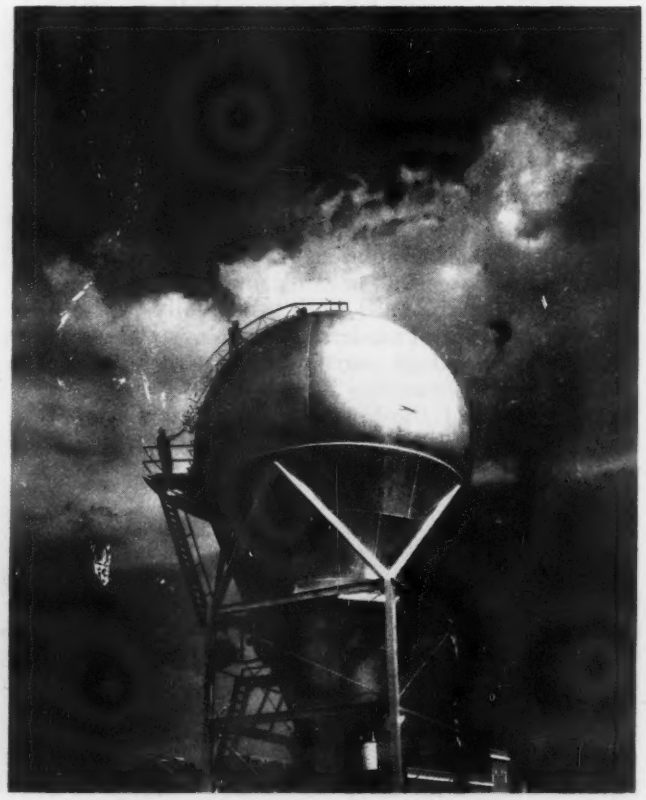
The full significance of these closing moments before the final factual test was *not* lost on these men of science. They fully knew their position as pioneers into another age. They also knew that one false move would blast them and their entire effort into eternity. Before the assembly started a receipt for the vital matter was signed by Brig. Gen. Thomas F. Farrell, General Groves deputy. This signalized the formal transfer of the irreplaceable material from the scientists back to the Army, which had originally produced it at one of its great separation plants.

During final preliminary assembly, a bad few minutes developed when the assembly of an important section of the bomb was delayed. The entire unit was machine-tooled to the finest measurement. The insertion was partially completed when it apparently wedged tightly and would go no farther. Dr. Bacher, however, was undismayed and reassured the group that time would solve the problem. In three minutes time, Dr. Bacher's statement was verified and basic assembly was completed without further incident.

Specialty teams, comprised of the top men on specific phases of science, all of which were bound up in the whole, took over their specialized parts of the assembly.

On Saturday, July 14, the unit which was to determine the success or failure of the entire project was elevated to the top of the steel tower. All that day and the next, the job of preparation went on. In addition to the apparatus necessary to cause the detonation, complete instrumentation to determine all the

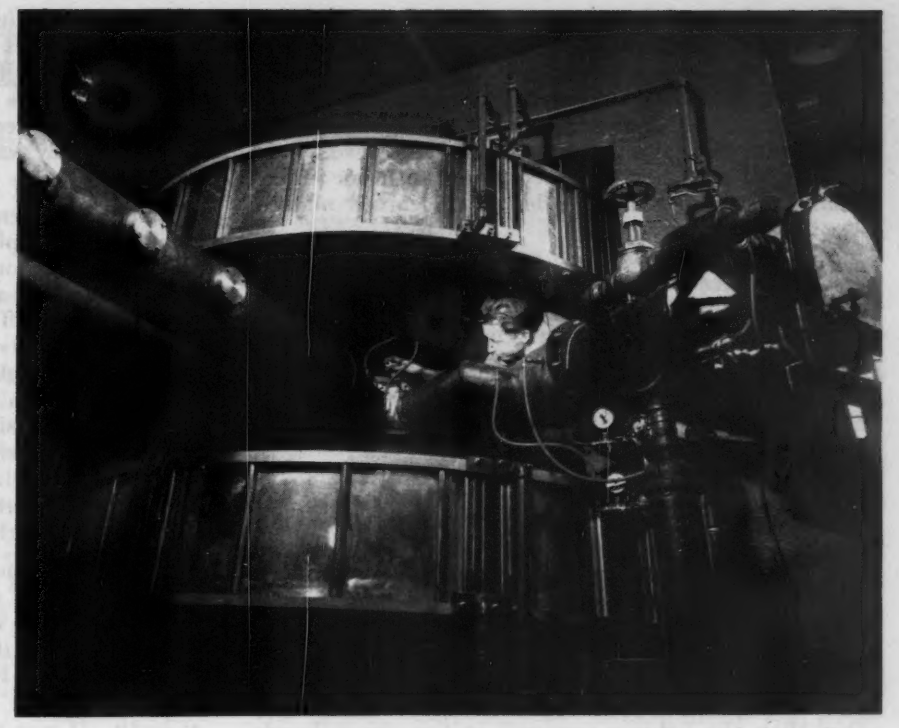
*The Westinghouse cyclotron, one of the first to be used for atomic research*



reactions of the bomb was rigged on the tower.

The ominous weather which had dogged the assembly of the bomb had a very sobering effect on the assembled experts whose work was accomplished amid lightning flashes and peals of thunder. The weather, unusual and upsetting, blocked aerial observation of the test. It even held up the actual explosion scheduled at 4 a.m. for an hour and a half. For many months the approximate date and time had been set and had been one of the high level secrets of the best kept secret of the entire war.

Nearest observation point was set up ten thousand yards south of the tower where in a timber and earth shelter the controls for the test were located. At a point seventeen thousand yards from the tower at a point which would give the best observation the key figures in the atomic bomb project took their posts. These included General Groves, Dr. Vannevar Bush, head of the Office of Scientific Research and Development, and Dr. James B. Conant, president of Harvard University.



*M. I. T.'s own cyclotron in Building 44*

Actual detonation was in charge of Dr. K. T. Bainbridge of Massachusetts Institute of Technology. He and Lieutenant Bush, in charge of the Military Police Detachment, were the last men to inspect the tower with its cosmic bomb.

At three o'clock in the morning the party moved forward to the control station. General Groves and Dr. Oppenheimer consulted with the weather men. The decision was made to go ahead with the test despite the lack of assurance of favorable weather. The time was set for 5:30 a.m.

General Groves rejoined Dr. Conant and Dr. Bush, and just before the test time they joined the many scientists gathered at the base camp. Here all present were ordered to lie on the ground, face downward, heads away from the blast direction.

Tension reached a tremendous pitch in the control room as the deadline approached. The several observation points in the area were tied in to the control room by radio and with twenty minutes to go, Dr. S. K. Allison of Chicago University took over the radio net and made periodic time announcements.

The time signals, "minus twenty minutes, minus fifteen minutes," and on and on, increased the tension to the breaking point as the group in the control room, which included Dr. Oppenheimer and General Farrell, held their breaths, all praying with the intensity of the moment which will live forever with each man who was there. At "minus forty-five seconds," robot mechanism took over and from that point on the whole great complicated mass of intricate mechanism was in operation without human control. Stationed at a reserve switch, however, was a soldier scientist ready to attempt to stop the explosion should the order be issued. The order never came.

At the appointed time, there was a blinding flash lighting up the whole area brighter than the brightest daylight. A mountain range three miles from the observation point stood out in bold relief. Then came a tremendous sustained roar and a heavy pressure wave which knocked down two men outside the control center. Immediately thereafter, a huge multi-colored surging cloud boiled to an altitude of over forty thousand feet. Clouds in its path disappeared. Soon the shifting substratosphere winds dispersed the now gray mass.

The test was over, the project a success.

The steel tower had been entirely vaporized. Where the tower had stood, there was a huge sloping crater. Dazed but relieved at the success of their tests, the scientists promptly marshalled their forces to estimate the strength of America's new weapon. To examine the nature of the crater, specially equipped tanks were wheeled into the area, one of which carried Dr. Enrico Fermi, noted nuclear scientist. Answer to their findings rests in the destruction effected in Japan today in the first military use of the atomic bomb.

Had it not been for the desolated area where the test was held and for the coöperation of the press in the area, it is certain that the test itself would have attracted far-reaching attention. As it was, many people in that area are still discussing the effect of the smash. A significant aspect, recorded by the press, was the experience of a blind girl near Albuquerque many miles from the scene, who, when the flash of the test lighted the sky before the explosion could be heard, exclaimed, "What was that?"

Interviews of General Groves and General Farrell give the following on-the-scene versions of the test. General Groves said: "My impressions of the night's high points follow: After about an hour's sleep I got up at 0100 and from that time on until about 0500 I was with Dr. Oppenheimer constantly. Naturally he was tense, although his mind was working at its usual extraordinary efficiency. I attempted to shield him from the evident concern of many of his assistants who were disturbed by the uncertain weather conditions. By 0400 we decided that we could probably fire at 0530. By 0400 the rain had stopped but the sky was heavily overcast. Our decision became firmer as time went on.

During most of these hours the two of us journeyed from the control house out into the darkness to look at the stars and to assure each other that the one or two visible stars were becoming brighter. At 0510 I left Dr. Oppenheimer and returned to the main observation point which was seventeen thousand yards from the point of explosion. In accordance with our orders I found all personnel not otherwise occupied massed on a bit of high ground.

Two minutes before the scheduled firing time, all persons lay face down with their feet pointing towards the explosion. As the remaining time was called over the loudspeaker from the ten-thousand-yard control station there was complete awesome silence. Dr. Conant said he had never imagined seconds could be so long. Most of the individuals in accordance with orders shielded their eyes in one way or another.

First came the burst of light of a brilliance beyond any comparison. We all rolled over and looked through dark glasses at the ball of fire. About forty seconds later came the shock wave followed by the sound, neither of which seemed startling after our complete astonishment at the extraordinary lighting intensity.

A massive cloud was formed which surged and billowed upward with tremendous power, reaching the substratosphere in about five minutes.

Two supplementary explosions of minor effect other than the lighting occurred in the cloud shortly after the main explosion.

The cloud traveled to a great height first in the form of a ball, then mushroomed, then changed into a long trailing chimney-shaped column and finally was sent in several directions by the variable winds at the different elevations.

Dr. Conant reached over and we shook hands in mutual congratulations. Dr. Bush, who was on the other side of me, did likewise. The feeling of the entire assembly, even the uninitiated, was one of profound awe. Drs. Conant and Bush and myself were struck by an even stronger feeling that the faith of those who had been responsible for the initiation and the carrying on of this Herculean project had been justified."

General Farrell's impressions are: "The scene inside the shelter was dramatic beyond words. In and around the shelter were some twenty odd people concerned with last minute arrangements. Included were Dr. Oppenheimer, the Director, who had borne the great scientific burden of developing the weapon from the raw materials processed in Tennessee and the State of Washington, and a dozen of his key assistants, Dr. Kistiakowsky, Dr. Bainbridge, who supervised all the detailed arrangements for the test; the weather expert, and several others. Besides these, there were a handful of soldiers, two or three Army officers and one Naval officer. The shelter was filled with a great variety of instruments and radios.

For some hectic two hours preceding the blast, General Groves stayed with the Director. Twenty minutes before zero hour, General Groves left for his station at the base camp, because it provided a better observation point.

Just after General Groves left, announcements began to be broadcast of the interval remaining before the blast to the other groups participating in and observing the test. As the time interval grew smaller and changed from minutes to seconds, the tension increased by leaps and bounds. Everyone in that room knew the awful potentialities of the thing that they thought was about to happen. The scientists felt that their figuring must be right and that the bomb had to go off but there was in everyone's mind a strong measure of doubt.

We were reaching into the unknown and we did not know what might come of it. If the shot were successful, it was a justification of the several years of intensive effort of tens of thousands of people — statesmen, scientists, engineers, manufacturers, soldiers, and many others in every walk of life.

In that brief instant in the remote New Mexico desert, the tremendous effort of the brains and brawn of all these people came suddenly and startlingly to the fullest fruition. Dr. Oppenheimer, on whom had rested a very heavy burden, grew tenser as the last seconds ticked off. He scarcely breathed. He held on to a post to steady himself. For the last few seconds, he stared directly ahead and then when the announcer shouted 'Now!' and there came this tremendous burst of light followed shortly thereafter by the deep growling roar of the explosion his face relaxed into an expression of tremendous relief. Several of the observers standing back of the shelter to watch the lighting effects were knocked flat by the blast.

The tension in the room let up and all started congratulating each other. Everyone sensed 'This is it!' No matter what might happen now all knew that the impossible scientific job had been done. Atomic fission would no longer be hidden in the cloisters of the theoretical physicists' dreams. It was almost full grown at birth. It was a great new force to be used for good or for evil. There was a feeling in that shelter that those concerned with its nativity should dedicate their lives to the mission that it would always be used for good and never for evil.

Dr. Kistiakowsky threw his arms around Dr. Oppenheimer and embraced him with shouts of glee. Others were equally enthusiastic. All the pent-up emotions were released in those few minutes and all seemed to sense immediately that the explosion had far exceeded the most optimistic expectations and wildest hopes of the scientists. All seemed to feel that they had been present at the birth of a new age — The Age of Atomic Energy — and felt their profound responsibility to help in guiding into right channels the tremendous forces which had been unlocked for the first time in history.

As to the present war, there was a feeling that no matter what else might happen, we now had the means to insure its speedy conclusion and save thousands of American lives. As to the future, there had been brought into being something big and something new that would prove to be immeasurably more important than the discovery of electricity or any of the other great discoveries which have so affected our existence.

The effects could well be called unprecedented, magnificent, beautiful, stupendous and terrifying. No man-made phenomenon of such tremendous power had ever occurred before. The lighting effects beggared description. The whole country was lighted by a searing light with the intensity many times that of the midday sun. It was golden, purple, violet, gray and blue. It lighted every peak, crevasse and ridge of the nearby mountain range with a clarity and beauty that cannot be described but must be seen to be imagined. It was that beauty the great poets dream about but describe most poorly and inadequately. Thirty seconds after the explosion came first, the air blast pressing hard against the people and things, to be followed almost immediately by the strong, sustained awesome roar. Words are inadequate tools for the job of acquainting those not present with the physical, mental and psychological effects. It had to be witnessed to be realized."

# THE NITROPARAFFINS

By EDWARD M. KOSOWER, 2-48

## PART I—SYNTHESIS OF NITROPARAFFINS

*Pictures Courtesy Commercial Solvents Corporation*

IN the last decade, a class of compounds known as the nitroparaffins was catapulted from a place on the laboratory shelf to a position as important, new industrial chemicals. This, as we shall see later, was the result of research directed by Dr. H. B. Hass of Purdue University, and was an amazing example of how organized research can produce in a relatively few years what might have taken independent workers decades to do. Of course, the atomic bomb proved this beyond a shadow of doubt, showing that while independent research, though basic and far-reaching, was very important, nevertheless desired results could be obtained much more rapidly by a well-coördinated and well-directed group. This principle of subsidized and organized research is an important point in a future Federal research program. Not only, then, was a process developed to produce these compounds on a large scale, but the uses and derivatives of the nitroparaffins were explored and found capable of almost infinite possibilities. To understand the development and evolution which culminated in the industrial process, we will consider the historical background of the various preparative methods.

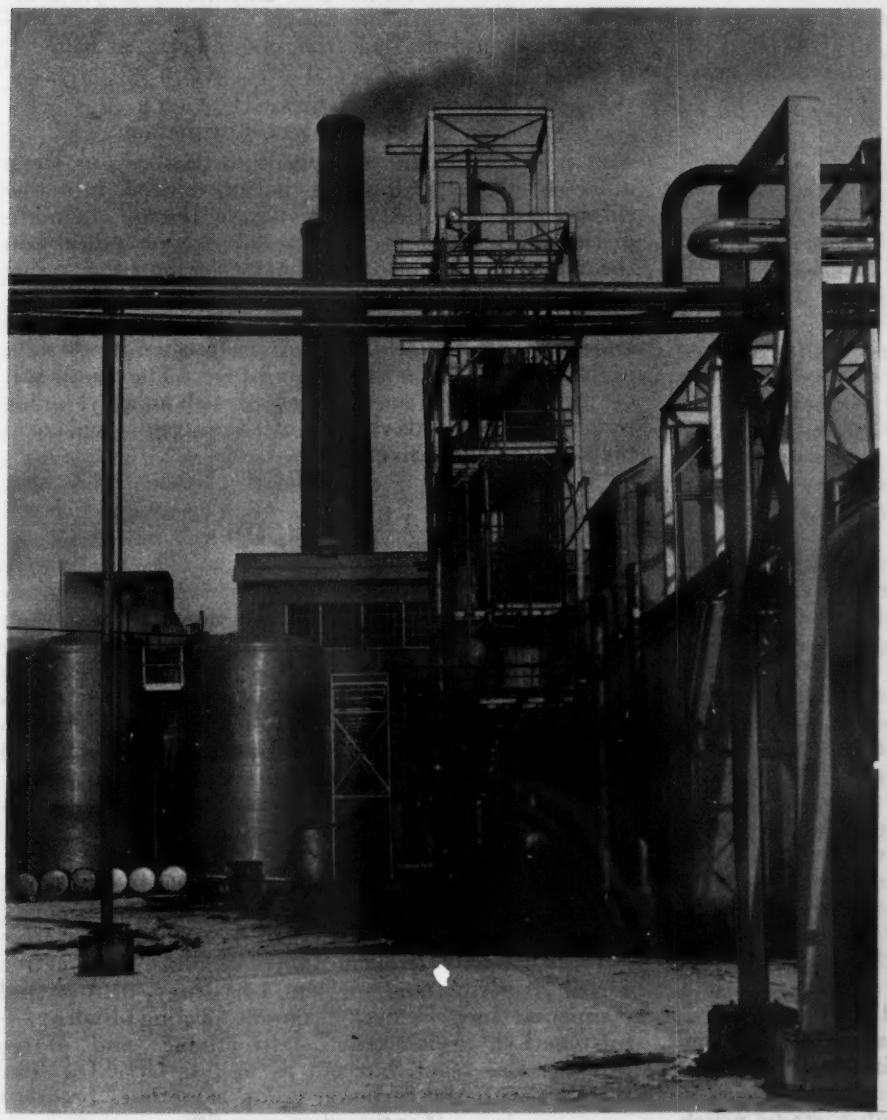
In 1872, Meyer, the famous German organic chemist, and Stüber reported that the reaction between amyl iodide and silver nitrite had yielded a mixture of nitropentane and amyl nitrite. This was the first recorded synthesis of a nitroparaffin. The reaction is somewhat peculiar, since it was the heavy metal nitrite that gave rise to the nitro compound; sodium nitrite and potassium nitrite give little or no nitro compound. Silver nitrite had a normal nitrite structure, corresponding to AgONO or $Ag^+ ONO^-$. Recently, Reynolds and Adkins attempted to explain this by postulating that an addition complex was formed between the heavy metal nitrite and the organic halide. Either constituent could then affect the course of the subsequent decomposition, as follows:

$$RCH_2X + MNO_2 \rightarrow RCH_2X \cdots MNO_2$$

$$RCH_2X \cdots MNO_2 \rightarrow RCH_2ONO + RCH_2NO + MX$$

This general series of reactions became known as the Victor Meyer reaction, and has found extended use in the synthesis of the nitroaliphatics. It has been found applicable to the preparation of polynitroparaffins, nitro-alcohols, nitro-olefins, nitroethers, nitroketones, and a host of other compounds of this class.

Five months after the first nitroparaffin synthesis, Kolbe discovered a modification of this reaction. He reacted the salts of α-halocarboxylic acids with metallic nitrites; first, unstable salts of the corresponding nitroacid were formed — then, these broke down forming a metallic bicarbonate, a metallic halide, and a nitroparaffin. This modification will give good yields of nitroparaffin for short chain acids only, especially for α-chloracetic acid when it is converted into nitromethane. The latter



*The nitroparaffins are separated by fractional distillation in these huge towers.*

*Developmental work on the nitroparaffins was centered in a semi-works located at Terre Haute, Indiana*

experiment is performed in many elementary organic laboratory courses and as much as fifty per cent of nitroparaffin can be obtained from the α-chloracetic acid.

$$\begin{array}{l} \mathrm{Cl} \qquad\qquad\qquad\quad \mathrm{NO_2} \\ | \qquad\qquad\qquad\quad | \\ \mathrm{RCHCOONa+MNO_2 \rightarrow RCHCOONa} \\ \rightarrow \mathrm{RCH_2NO_2+NaHCO_3+NaCl} \end{array}$$

The Victor Meyer reaction and direct nitration are the only general methods known at present for the preparation of basic nitroparaffins, all items such as cost, availability of raw materials, and time of preparation being considered.

There are divers less important methods for preparing nitroparaffins in the laboratory; one might wonder at their consideration in this paper if they are less important. Here it might be best to emphasize that a paper should cover as many angles as possible of a given subject — one never knows what ideas might lay hidden within every detail, what someone else with a different viewpoint would see.

Primary amines may be oxidized to a nitroparaffin, supposedly by way of an intermediate β-alkylhydroxylamine. Methylamine, ethylamine, tertiary-butylamine, and benzylamine have been oxidized to the corresponding nitro-compounds. In the oxidation of methylamine, formic acid and formhydroxamic acid can be isolated as products of side-reactions. This method for preparation is less valuable than others but it is interesting because the amines are easily obtainable from cheap, accessible sources.

Alkyl nitrites may rearrange when heated, or otherwise activated, to a nitroparaffin. For instance, when ethyl nitrite and hydrogen are passed over a finely divided nickel catalyst, amines are formed. The mechanism explaining this peculiar formation of a carbon-nitrogen bond where before was a carbon-oxygen bond, states that ethyl nitrite may have rearranged to a nitroparaffin which then was reduced to the amine.

Certain of the unsaturated aliphatic hydrocarbons add nitrogen tetroxide to yield dinitroparaffins. The reaction between olefins and the oxides of nitrogen is quite complex and worthy of a further study which cannot be undertaken here. The olefins are hydrocarbons containing at least one double bond. In reacting, one might say that the double bond opens up and each carbon combines with a part of the Nitrogen Tetroxide molecule, $N_2O_4$ or $-NO_2$. 2, 3-Dimethyl-2-butene reacts to form 2, 3-Dinitro-2, 3-Dimethlybutane.

$$\begin{array}{l} (\mathrm{CH_3})_2\mathrm{C=C(CH_3)_2+N_2O_4} \\ \qquad\qquad\quad \mathrm{NO_2\ NO_2} \\ \qquad\qquad\quad | \qquad | \\ \rightarrow (\mathrm{CH_3})_2\mathrm{C-C(CH_3)_2} \end{array}$$

Tetra-chlor- and tetra-bromoethylenes give the corresponding nitrated product by this mechanism.

Aside from the various direct nitration processes which will be discussed later, the remaining preparative methods may be classified under the general heading of nitroparaffin derivattves. These are the nitroparaffins of a more complicated nature which are made from the simpler, more easily prepared compounds.

Halonitroparaffins can be converted into alkylated nitroparaffins upon treatment with zinc alkyls. It is possible to prepare tertiarynitrobutane from chloropicrin, as below:

$$\begin{array}{l} (\mathrm{Cl})_3\mathrm{CNO_2+Zn(CH_3)_2} \rightarrow \mathrm{CH_3(Cl)_2CNO_2+Zn(CH_3)_2} \rightarrow \\ (\mathrm{CH_3})_2(\mathrm{Cl})\mathrm{CNO_2+Zn(CH_3)_2} \rightarrow (\mathrm{CH_3})_3\mathrm{CNO_2} \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \text{tert.-nitrobutane} \end{array}$$

This reaction can be controlled, so that two or three different alkyl groups can be introduced into the chloropicrin molecule. A variation on the use of chloropicrin, would be to use a monohalo compound, obtain the monoalkylated nitroparaffin, rechlorinate in alkaline solution, and so forth.

The nitroparaffins are tautomeric with weak acids known as nitronic acids. These are formed by dissolving the nitroparaffin in a strong base. The metal salt of the nitronic acid may be reacted with an alkyl halide to give either an alkyl ester of the nitronic acid, or a higher nitro derivative.

$$\begin{array}{l} \qquad\qquad\qquad\qquad\quad \mathrm{RCH=NO_2R'+MX} \\ \mathrm{RCH=NO_2M+R'X} \nearrow \\ \qquad\qquad\qquad\quad \searrow \mathrm{RCHR'} \qquad\quad +\mathrm{MX} \\ \qquad\qquad\qquad\qquad\quad | \\ \qquad\qquad\qquad\qquad\quad \mathrm{NO_2} \end{array}$$

The nitronic esters are usually unstable and when warmed or allowed to stand, decompose with varying degrees of violence (depending on the conditions). The decomposition, if controlled properly, is very interesting as regards resulting material. The esters decompose to give the oxime of RCH=O (also where H=R) and the aldehyde R″CHO (where R″=R′ less a $CH_2$ group). The best yield is obtained in this reaction with the iodides of the alkyl group; the sulfates are also suitable.

Nitromethane is extremely reactive, and as such, finds use in adding a nitro group to compounds active enough to take part in a condensation reaction. Active ketones condense to form dinitroparaffins. Less active carbonyl groups tend to form a hydroxy, nitromethyl compound such as cyclohexanone forming l-hydroxy-l-nitromethyl cyclohexane. Nitroethane and nitropropane also react, but not as well as $CH_3NO_2$. The reaction with the carbonyl group sometimes proceeds

(*Continued on page 52*)

# THERMODYNAMICS IN THE SYNTHESIS OF METHANOL

By ANTONIO D. FILARDI, 10-45

THERMODYNAMICS is that field of study which presents us with criteria for the evaluation of energy relationships. In its more theoretical aspects it finds extensive use in predicting so-called efficiencies of turbines, steam and internal combustion engines, refrigeration and heat engine cycles, and so forth by use of the Carnot and Stirling air cycles. From a less theoretical viewpoint, thermodynamics finds application in the treatment of heat exchange work and in predicting chemical equilibria, the latter of which will occupy us here.

Before entering into chemical applications, a review of the thermodynamic relationships would not be amiss. The law of the conservation of energy may be stated as the First Law of Thermodynamics

$$\Delta E = q - w \qquad (1)$$

where $\Delta E$ = change in internal energy
$q$ = heat entering or leaving the system
$w$ = work done on or by the system.

We use the symbol $\Delta E$ rather than $E_2 - E_1$ for the change in internal energy because we have no way of determining the absolute value of the internal energy. If we limit ourselves to reversible changes we may then say that the work done by moving the boundary of a system, the batch work, is

$$w = \int_{v_1}^{v_2} p\, dv.$$

It must be remembered that this holds only for a process which is reversible, *i.e.*, the driving forces are always infinitesimally greater than the resisting forces. As a consequence of this, it is apparent that a reversible change must take place over an infinite interval of time and therefore exists no more than does the frictionless plane we were told about in Mechanics.

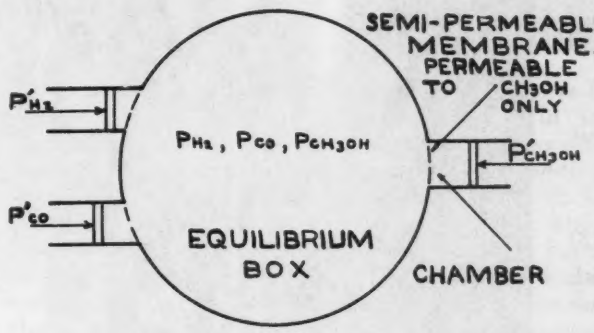



*Figure 1*

A new term, the enthalpy, is defined as

$$\Delta H = \Delta E + \Delta(PV)$$

and since

$$\int p\, dv = \Delta(PV) - \int v\, dp \qquad (2)$$

then

$$\Delta H = q + \int v\, dp. \qquad (3)$$

The term $+\int v\, dp$ is called the flow work and may be pictured as the work delivered to a shaft by a flowing fluid. It is seen that the batch work is greater than the flow work by the term $\Delta(PV)$ which is the work done in moving back the atmosphere in, say, the expansion of a gas. The term $-\int v\, dp$ is the negative of the net or "useful" work that can be obtained from a system. For an isothermal process this work is called the change in free energy of the system and is given the symbol $\Delta F$ whence

$$\Delta F = -\int v\, dp. \qquad (3')$$

Let us consider the gas phase reaction

$$CO + 2H_2 \rightarrow CH_3OH \text{ (methanol)},$$

assuming momentarily that all the components are *perfect* gases following the relationship $PV = nRT$. In Figure 1 the gases are contained in the chambers at the pressures $p'H_2$, etc. Now if the gases are compressed *reversibly* and enter the equilibrium box at their equilibrium pressure, a certain amount of work must be done which is also equal to the change in free energy. Thus for hydrogen

$$\Delta F_{H_2} = -\int v\, dp = -nRT \ln \frac{P_{H_2}}{P'_{H_2}} \qquad (4)$$

Similar equations may be written for CO and $CH_3OH$. For $H_2$ $n$ would equal 2 since two moles of $H_2$ are needed for each mole of CO. The final relationship is:

$$\Delta F = \Delta F_{H_2} + \Delta F_{CO} + \Delta F_{CH_3OH}$$

$$= -RT \ln \frac{P_{CH_3OH}}{P^2_{H_2} \times P_{CO}} + RT \ln \frac{P'_{CH_3OH}}{P'^2_{H_2} \times P'_{CO}} \qquad (5)$$

By arbitrarily letting $\dfrac{P'_{CH_3OH}}{P'^2_{H_2} \times P'_{CO}} = 1$ and writing $\Delta F$ as $\Delta F^\circ$ we then obtain the standard free energy change ($\Delta F^\circ$) (which refers to a reaction at the standard state) as a function of the equilibrium pressures alone:

$$\Delta F^\circ = -RT \ln \frac{P_{CH_3OH}}{P^2_{H_2} \times P_{CO}} \qquad (6)$$

and since

$$\frac{P_{CH_3OH}}{P^2_{H_2} \times P_{CO}} = K_p \qquad (7)$$

[where $K_p$ is the equilibrium constant]
then

$$\Delta F^\circ_{298} = -RT \ln K_p \qquad (8)$$

In writing this equation the temperature is usually specified.

This equation is strictly correct only for perfect gases and can be made to apply for real gases by defining

$$K_f = K_p K_\gamma$$

where $K_f$ is the value obtained by using fugacities in the equilibrium equation instead of pressures. $K_\gamma$ is the value obtained by using coefficients of activity instead of pressures. Thus for real gases we have

$$\Delta F^\circ = -RT \ln K_f \qquad (9)$$

It is obvious that $K_f$ and $K_\gamma$ are terms devised to give a more nearly correct answer. Fugacity may be thought of as a corrected pressure with $\gamma$ being the correction factor according to the equation

$$\gamma P = f.$$

Evaluation of $f$ and $\gamma$ is done by means of charts* drawn up from data on the hydrocarbons.

*See Weber: "Thermodynamics for Chemical Engineers."

To evaluate $K_f$ we must know the value of $\Delta F°$. By definition

$$C_p=\left(\frac{\partial H}{\partial T}\right)_p$$

or

$$\left(\frac{\partial \Delta H}{\partial T}\right)=\Delta C_p.$$

$C_p$ is the heat capacity at constant pressure. $\Delta C_p$ is merely the difference between the heat capacities of the products and the reactants. For our problem

$$C_{p\,CH_3OH}=2+.03T$$
$$2(C_{p\,H_2})=2[6.88+.066\times10^{-3}T+2.79\times10^{-7}T^2]$$
$$C_{p\,CO}=[6.25+2.09\times10^{-3}-4.59\times10^{-7}T^2]$$

thus

$$\Delta C_p=18+2.21\times10^{-3}T-.99\times10^{-7}T^2$$

and

$$\Delta H=\Delta H_0+\int_{T_0}^{T_1}\Delta C_p dt$$

$\Delta H_0$ is the change in enthalpy that occurs during the reaction taking place at temperature $T_0$. This is determined experimentally and our final equation for the methanol reaction is

$$\Delta H=-17{,}538+18.027+.01394T^2 -33\times10^{-6}T^3. \quad (11)$$

Now combining equations 3 and 3′ we have for the reversible case

$$\Delta F=\Delta H-q=\Delta H-T\Delta S \quad (12)$$

where $\Delta S$ is the change in entropy. At constant pressure

$$\Delta F=-\int v\,dp=0$$

and

$$\Delta S=\left(\frac{\Delta H}{T}\right)_p$$

and by the definition of $C_p$ this may be put into the form

$$\left(\frac{d\Delta S}{dT}\right)_p=\frac{\Delta C_p}{T} \quad (13)$$

Differentiating equation 12 with respect to $T$ with constant pressure

$$\left(\frac{\partial \Delta F}{\partial T}\right)_p=\left(\frac{\partial \Delta H}{\partial T}\right)_p-T\left(\frac{\partial \Delta S}{\partial T}\right)-\Delta S \quad (14)$$

Subtracting equation 13 from equation 14:

$$\left(\frac{\partial \Delta F}{\partial T}\right)_p=-\Delta S=\frac{\Delta F-\Delta H}{T}$$

which may be put in the form

$$\frac{\partial\left(\frac{\Delta F}{T}\right)}{\partial T}=-\frac{\Delta H}{T^2}$$
$$\frac{\Delta F}{T}=-\int\frac{\Delta H}{T^2}dt$$

Since we know $\Delta H$ as a function of $T$ by (equation 11)

$$\frac{\Delta F}{T}=+\int\left[\frac{17{,}538}{T^2}+\frac{18.02}{T}\right.$$
$$\left.-.01394+33\times10^{-6}T\right]dt$$
$$\frac{\Delta F}{T}=-\frac{17{,}538}{T}+18.02\ ln\ T$$
$$-.01394T+\frac{33\times10^{-6}}{2}T^2+I$$
$$\Delta F=-17{,}538+18.02T\ ln\ T$$
$$-.01394T^2+\frac{33\times10^{-6}}{2}T^3+IT \quad (15)$$

The value of $I$ is determined from thermal data. Recalling equation 9 we obtain for the methanol synthesis

$$\log_{10}K_f=\frac{3810}{T}-9.01\log_{10}T +.00302T+12.9. \quad (16)$$

Using equation 16 we are able to predict the equilibrium composition when a mixture of CO and $H_2$ are reacted at any pressure and temperature. Industrially the reaction is carried out at 300° C. under a pressure of 150 atmospheres. The temperature and pressure used depend on such things as strength of materials,

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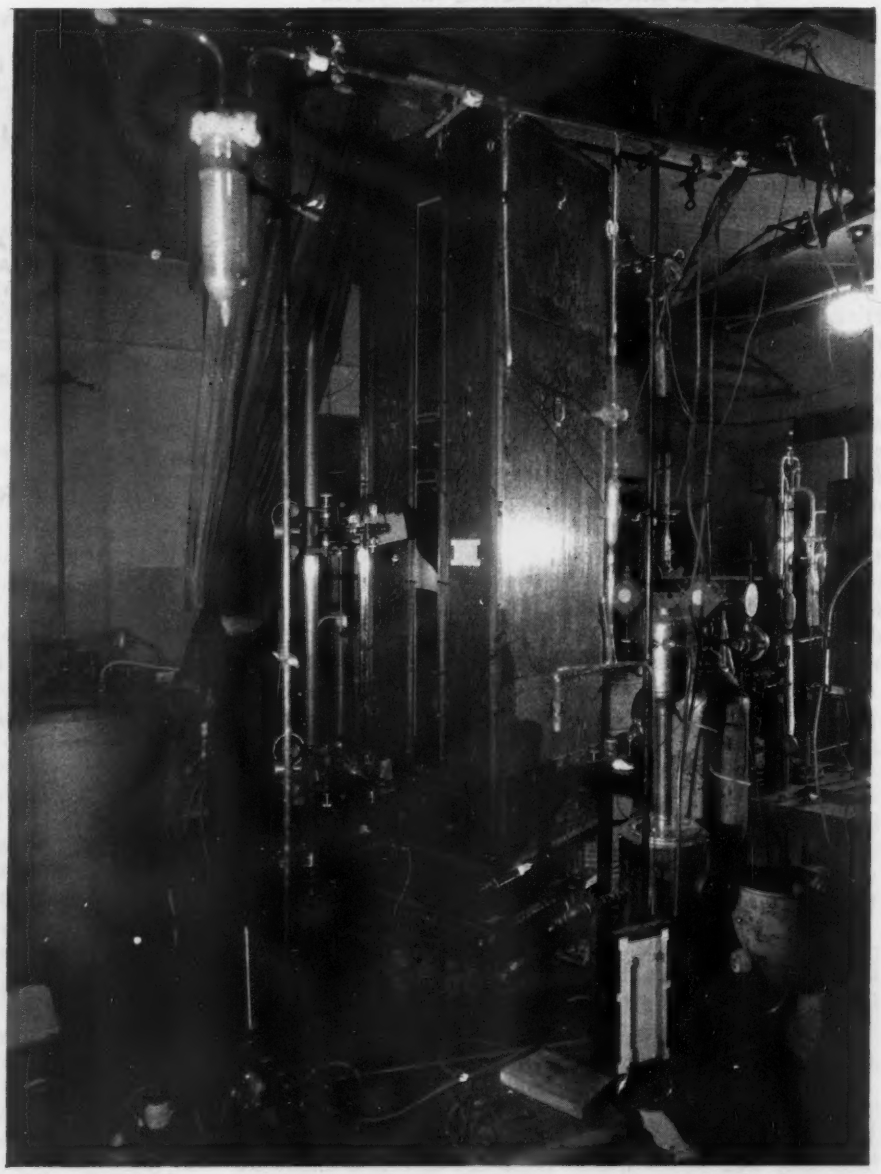


***The gas thermometric equipment in operation***

# ALUMNUS OF THE MONTH

## DONALD GLEN FINK, '33

Donald Glen Fink (VI-C '33) was born November 8, 1911 in Englewood, New Jersey. He attended public schools, graduating from Englewood High School in 1929. During high school years he followed two interests which have since shaped his career, amateur radio and journalism. In 1927 his amateur station was licensed and in the same year he was appointed editor of the school newspaper. He has been pursuing both interests, in one form or another, ever since.

Fink entered Technology as a freshman and pursued the Communications Option of Course VI. In his junior year he was a member of Tech's first course in engineering electronics, a laboratory course under Professor T. S. Gray, in which he constructed several electron tubes. As his principal extracurricular activity he chose the *Tech Engineering News*, serving as assistant editor, associate editor and editor-in-chief in successive years. He was active in undergraduate A.I.E.E. affairs, was president of his social fraternity, Phi Mu Delta, and president of the local chapter of Tau Beta Pi in his senior year. His thesis, a study of the action of electronic oscillators, was performed on the differential analyzer.

Immediately following graduation in 1933, Fink was appointed research assistant at Tech, serving in the Departments of Geology and Electrical Engineering under Professors Schlicter and Hazen respectively. His geologic research was a project involving large-scale electrical prospecting to study the electrical characteristics of the deep crust. In the Electrical Engineering Department he worked on the development of lamp sources for the cinema integraph. He was elected a member of Sigma Xi in 1934.

In June, 1934, he resumed his journalistic career by joining the staff of the magazine *Electronics*. Serving first as a member of the editorial staff, he was appointed successively assistant editor, associate editor and managing editor. He served in the latter position from 1937 to 1941.

During these years on the staff of *Electronics*, Fink undertook two major efforts outside office hours, obtaining a M.Sc. degree at Columbia University and writing three books. The first, "Neon Signs," appeared in 1935, the second, "Engineering Electronics," in 1938, and the third, "Principles of Television Engineering," in 1940. His interest in television dates from undergraduate days, when he operated a scanning-disc receiver at his fraternity while the brothers were televised at the nearby station. Later, on advice of the editor of *Electronics*, he made television a particular specialty in his editorial and reporting work. In 1940–41 he served on the National Television System Committee, which set up the standards for the present-day television system. He edited the proceedings of the N.T.S.C. and in 1943 published them in a fourth book, "Television Standards and Practice." More recently, from 1944 to the present, he has served as a member of the Television Panel of the Radio Technical Planning Board, which has undertaken the postwar planning for nation-wide television service. In 1945 he was awarded a Radio Section Premium by the British Institution of

Electrical Engineers for his paper, "Television Broadcasting Practice in America — 1927 to 1944."

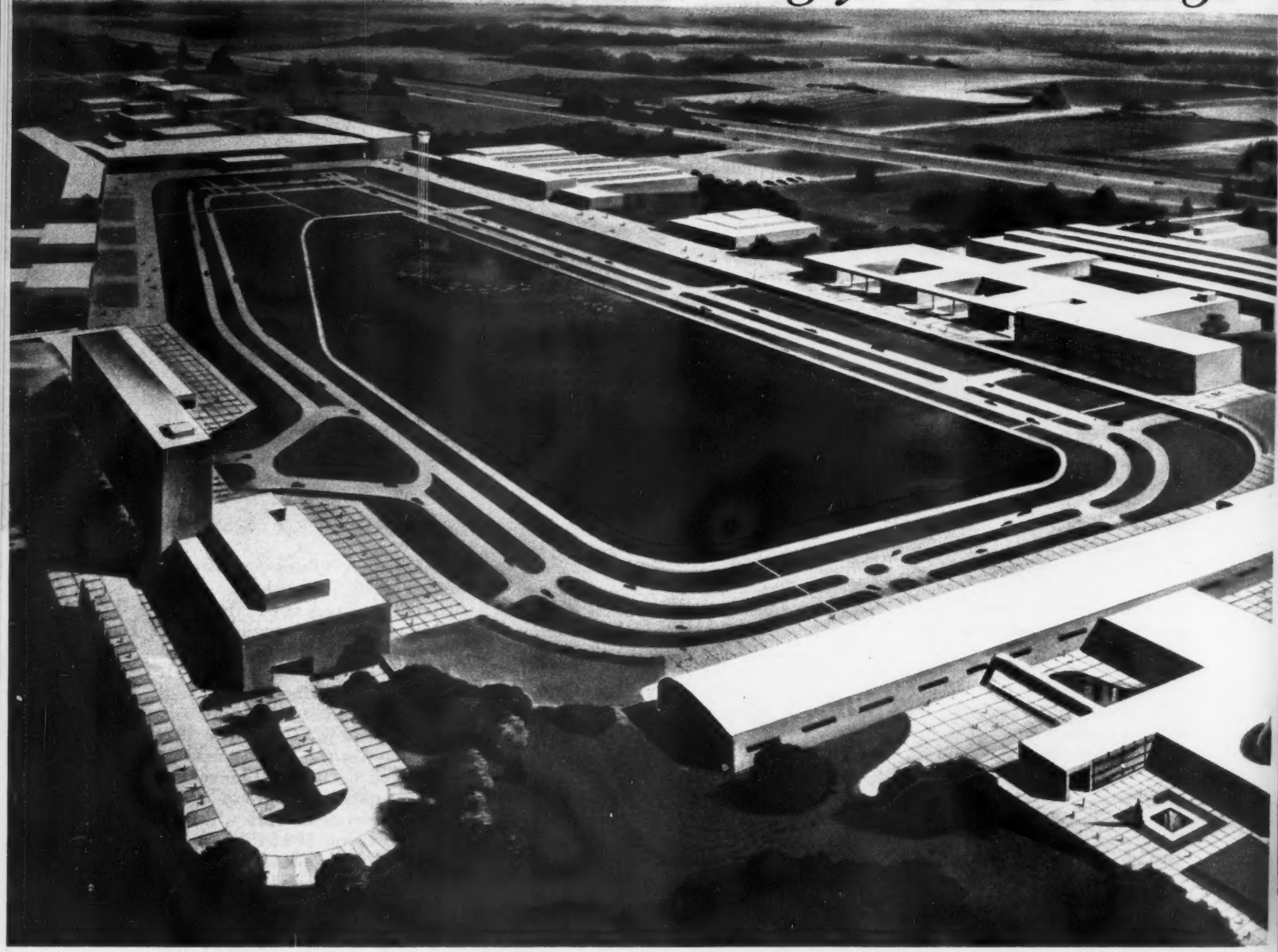
In 1940 he was designated by Eta Kappa Nu as one of three "outstanding young electrical engineers" of that year. The M. I. T. chapter of EKN recognized this by electing him to membership in May, 1941. At the initiation banquet, Professor Hazen asked him if he would take leave of absence from *Electronics* and join the Radiation Laboratory at M. I. T. then just beginning its phenomenal career in the development of radar. Fink joined the staff of Radiation Laboratory in June, 1941 and was assigned to the group which developed the Loran navigation system, work which he directed in 1943, as head of Division 11 of the Laboratory. In the course of his work he produced in 1942 a volume "Microwave Radar" for the use of the Laboratory staff and service personnel. This volume, the first textbook on radar ever published, was so secret at the time that a section of a local printing company was moved inside the Laboratory so that it could be printed in security.

In 1943, after a trip to England and Africa which was instrumental to setting up the Loran system for the guidance of Allied bombers over Germany, Fink transferred his activities to the Office of the Secretary of War to serve as Expert Consultant in the office of Professor E. L. Bowles, who had been head of the communications course at the Institute. Under Dr. Bowles he served to the end of the war as consultant on aircraft navigational matters and on radar for the use of the ground forces. He is at present a member of the War Department Committee on Air Navigation and

(*Continued on page 60*)

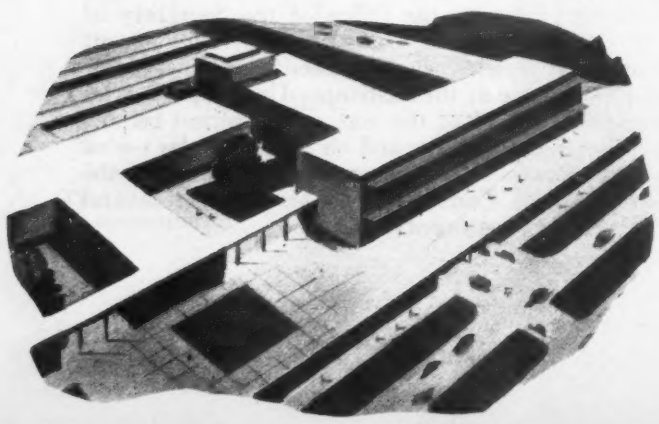
# TO SPEED THE PACE OF

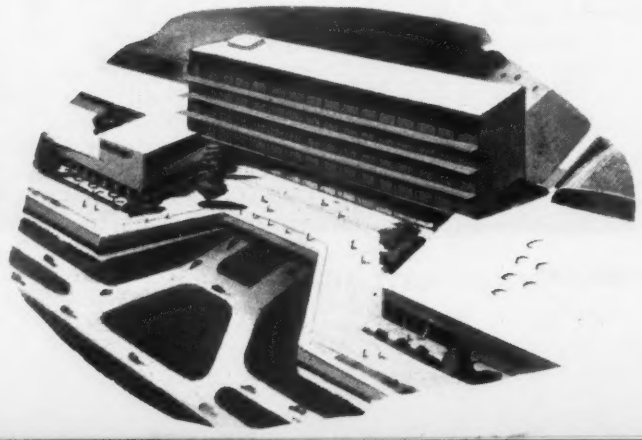
## *— and bring you <u>better</u> <u>things</u>*



**THE BUILDINGS** of the Technical Center will face a seven-acre lake. These buildings will be connected by a covered walk and vehicular roadway. Sketched below is the Advanced Engineering Building in which improvements will be quickly made in existing products.

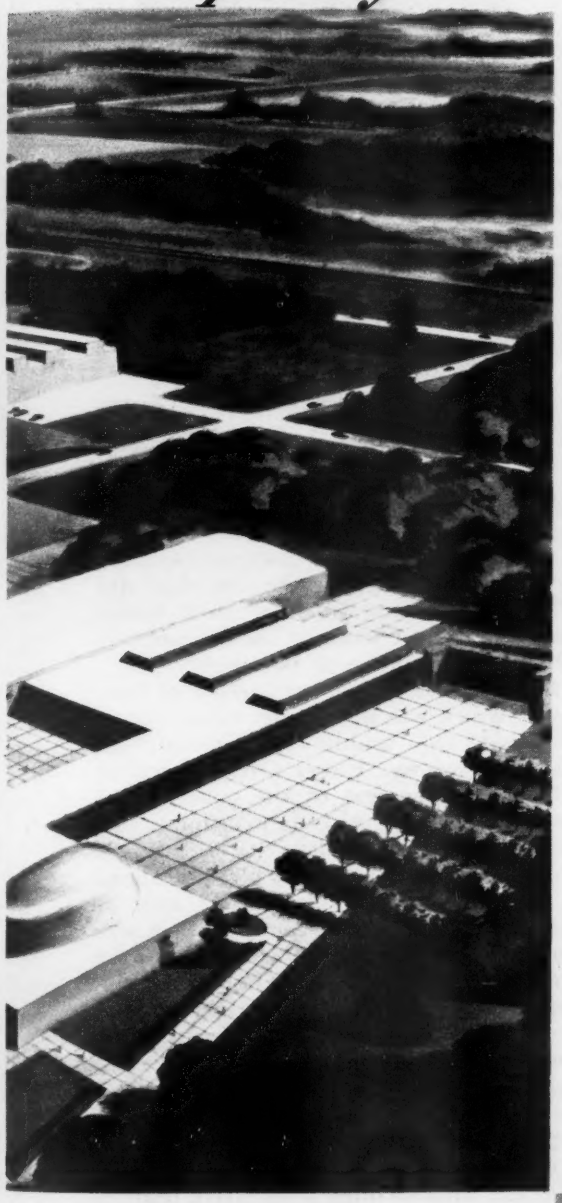
**LOCATED ON** a major highway leading from Detroit, access to the Center will be through the Administration Building sketched here. A system of modern roadways will provide practical opportunity to study traffic control as well as to make simple road tests of new car developments.



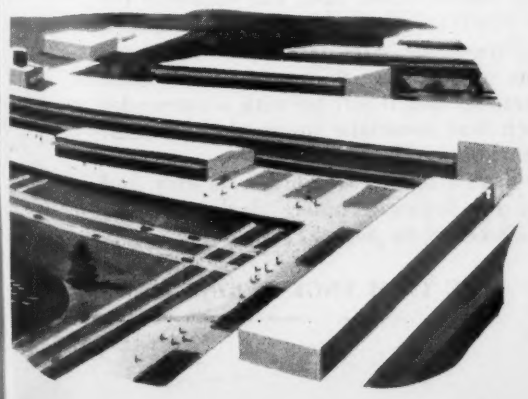


# PROGRESS

*more quickly*



**A FLOOD OF SUNSHINE** will pour into the southern windows of the Research Buildings where experimental work is carried on in such diverse fields as the study of chlorophyl, research into fuels and engine design.



**The New**

## GENERAL MOTORS TECHNICAL CENTER

**will be created to stimulate opportunities, promote employment and bring about MORE and BETTER THINGS FOR MORE PEOPLE**

THESE are times when the world cries out for new and finer things. There is a great hunger, broad as all mankind, for happier relationships among men — for greater individual opportunity for accomplishment, for more and better goods within reach of everyone.

It is by satisfying this hunger that we can bring greatest benefit to our national economy in the future. Through such action lies the road to more good jobs, to an ever-rising standard of living through the continual replacement of old things with new and better ones.

The General Motors Technical Center is dedicated to such an objective. It will occupy a 350-acre tract of land outside of Detroit as soon as conditions permit. Its purpose is to develop new things that add to the comfort and security of our living, and to enable existing things to be made more efficiently, hence at lower selling prices, so more people may own and enjoy them — all with expanding job opportunities.

It will shorten the time required to bring the work of creative thinkers out of the idea stage and into usable reality.

Here in groups of buildings designed especially for the purpose, General Motors will gather in advantageous and inspiring new surroundings the most modern facilities for research, advanced engineering, styling and the development of new manufacturing techniques.

Here physicists and engineers will discover new facts and convert them into new improved products. Stylists will give them new and more attractive form. Process engineers will develop better manufacturing techniques for making them.

Science here will go to work in the interest of economic progress. And history is full of proof that when science is so harnessed, more jobs are created, more comforts and conveniences are brought within reach of more people.

Serving as a source on which the engineering staffs of all of our Divisions may draw, the General Motors Technical Center will stimulate improvement in all General Motors products. Automobiles, refrigerators, Diesel engines, locomotives and other good and useful things may be expected to be improved at even faster pace than in the past.

But the work of the Technical Center will not be confined to existing things. It is dedicated to the idea that progress is the servant of mankind and that whosoever advances it not only helps himself but his fellow men. Its goal will be "more and better things for more people," whether that comes through improvement of the old or development of the new.

# GENERAL MOTORS

*MORE AND BETTER THINGS FOR MORE PEOPLE*

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## THE BATTLE DONE?

Today, as you read this, the world is once again at peace. The war is over, has been for two months, and by now we have gotten fairly accustomed to the idea. Already we are looking forward to the years ahead in which our scientists can once more devote their research to the ways of peace and our engineers need no longer build to destroy.

But it will not be easy after six years of bitter struggle for the peoples of the world to work together in the constructive ways of peace. This war was fought so that we might have a chance to create a world where nations may live with one another on a basis of equality and friendship rather than subjugation and hatred. And whether we may attain this goal will be determined not by how smoothly our factories convert from machine guns to typewriters but by how successful is the world-wide conversion from traditional suspicion and war-engendered hate to international coöperation.

Probably the major problem before us in this relation, and certainly the most obvious one, lies in our immediate and eventual treatment of our subjugated enemies Japan and Germany. The difficulties already met with in Germany have been relegated to the background of world events by the more recent and more intriguing details of the occupation of Japan. However, the German problem has by no means been solved. It is truly said that "in all of Germany you cannot find an acknowledged Nazi"; but the indoctrination of the people with the Nazi ideals and philosophy still remains and is continually shown in the arrogance and insolent behavior of the former Wehrmacht soldiers, the German police, the ex-members of the Hitler Youth Groups, and all the other fanatical disciples of the power-mad dictator.

As might be expected, the newspaper commentaries on our policy in Germany range anywhere from headlines claiming "Germans Stunned at Severity of U. S. Occupation Force," to condemnations of our military for enforcing their rule too lightly. Actually, it seems very unlikely that any of the Germans are "stunned" by the peace; in fact, of all the peoples of Europe they are probably the *least* stunned, since they, as conquerors, had a much easier time during the war than did their neighbors. The Germans are in a much better state than the Poles or the Czechs or the Russians — *they* have not been starved quite so thoroughly!

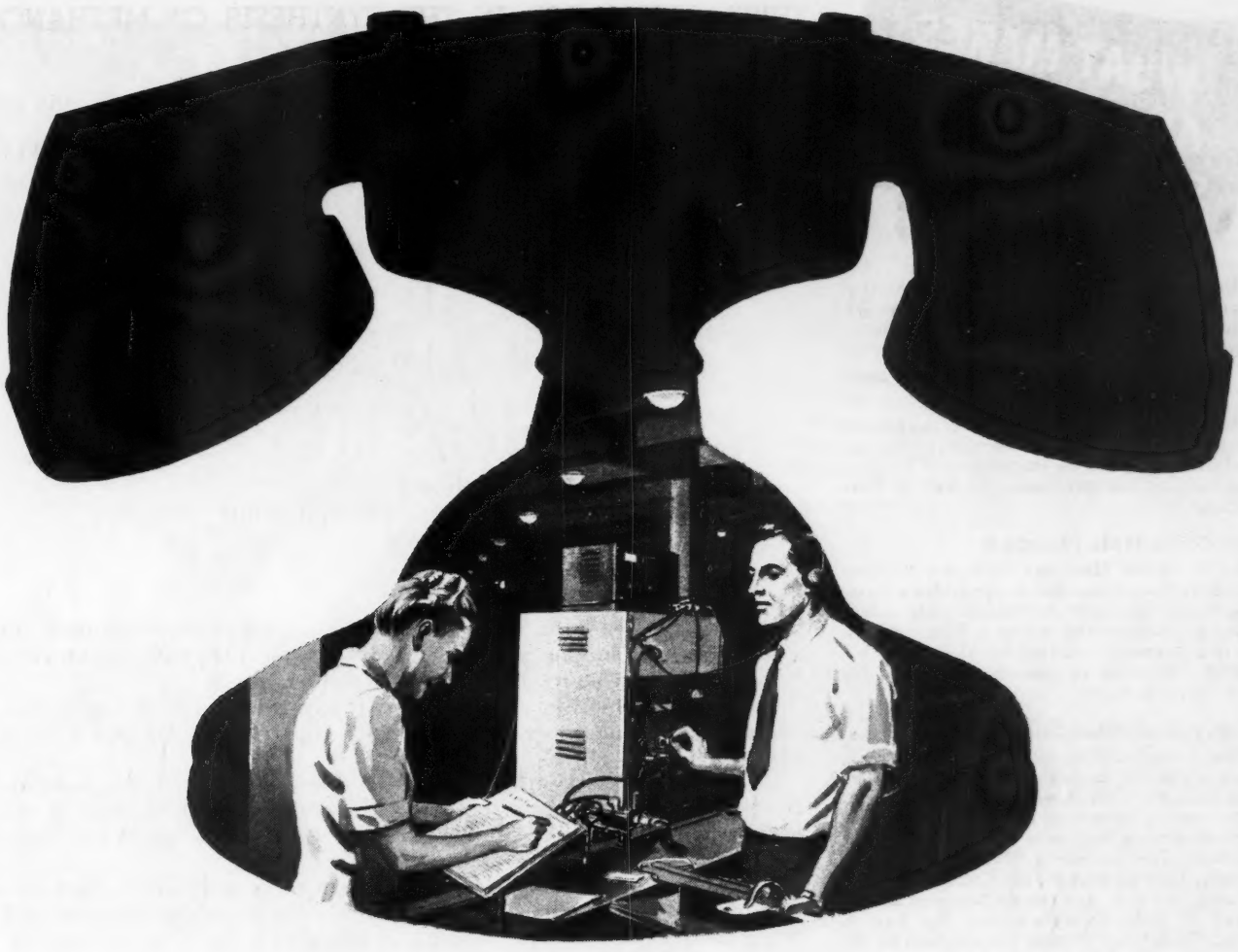
The tragic failure of the Allied occupation of Germany after World War I was due chiefly to an uncertain policy of following the "middle road" in our dealings with the defeated enemy. Either a very liberal or an extremely harsh enforcement of the peace terms might have proved successful, but the continual and ineffectual vacillating between these two extremes proved even worse than useless since it brought about the conditions under which the Nazi Party rose to power. That dangerous confusion of our aims then was caused by a general inattention and lack of interest both in our own country and in those of our Allies; the widespread feeling was that since the war was over we could now celebrate for one gay old time without a care for those foolish troubles abroad. Have we learned enough to feel a little differently about it today?

It seems unlikely that after so many years of militaristic training and thinking the German people would be very receptive to a gentle and idealistic approach. This time we are left with no other alternative than to enforce our terms without compromise, with a stern hand and the whole-hearted support of our occupation forces by us here at home.

Japan presents a similar though somewhat larger problem. Here our nation must take the supreme responsibility upon itself alone, and we must guard doubly against failure. The A-Bomb with its incomparable destruction saved many millions of lives, both American and Japanese; but it left us with a surrender on our hands which was somehow incomplete. Japan was defeated but not *beaten!*

In the first few days after the surrender we may find record of speeches by Japan's leaders declaring that

(*Continued on page 57*)



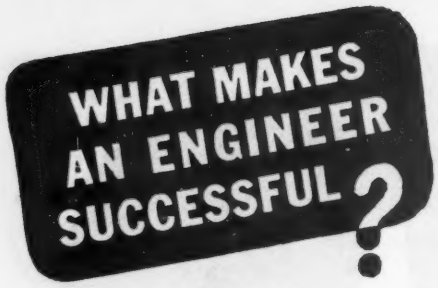
*Birthplace of* **50,000 RADARS**

Two years before Pearl Harbor the Government asked Bell Telephone Laboratories to help perfect radar as a military instrument. The Bell System, through the Western Electric Company, its manufacturing branch, became the nation's largest supplier of radar systems.

Bell scientists designed and developed many different types of radars—each for a specific job. One particular type was standard for B-29s in the Pacific for navigation, target location and high altitude bombing. Another directed all Navy guns over five inches.

This is not surprising, for radar development and production stem from the same roots that produced and continue to nourish this country's telephone system.

**BELL TELEPHONE SYSTEM**




● How does an engineering student eventually become vice president or head of a company? What—over and above his technical education—must he know to qualify as a top executive?

*The answer is: a basic understanding of practical business principles and methods.*

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## THERMODYNAMICS IN THE SYNTHESIS OF METHANOL

(*Continued from page 44*)

side reactions (reactions going on other than the one desired), and economic considerations.

Let us determine the yield of methanol under these conditions. From equation 16, substituting $T=573°\ K$ we get $K_f=2.4\times10^{-4}=KpK\gamma$. From equation 7

$$K_f=2.4\times10^{-4}=\frac{\left(\frac{x}{3-2x}\right)\pi}{\left(\frac{1-x}{3-2x}\right)\pi\left(\frac{2-2x}{3-2x}\right)\pi^2}\times\frac{\gamma_{CH_3OH}}{\gamma_{CO}\gamma_{H_2}}$$

$$=\left(\frac{x}{1-x}\right)\left(\frac{3-2x}{2-2x}\right)^2\frac{K_\gamma}{\pi^2}$$

$x$ = moles of Methanol
$1-x$ = moles of CO
$2-2x$ = moles of $H_2$
$\pi$ = 150 atmospheres
} at equilibrium

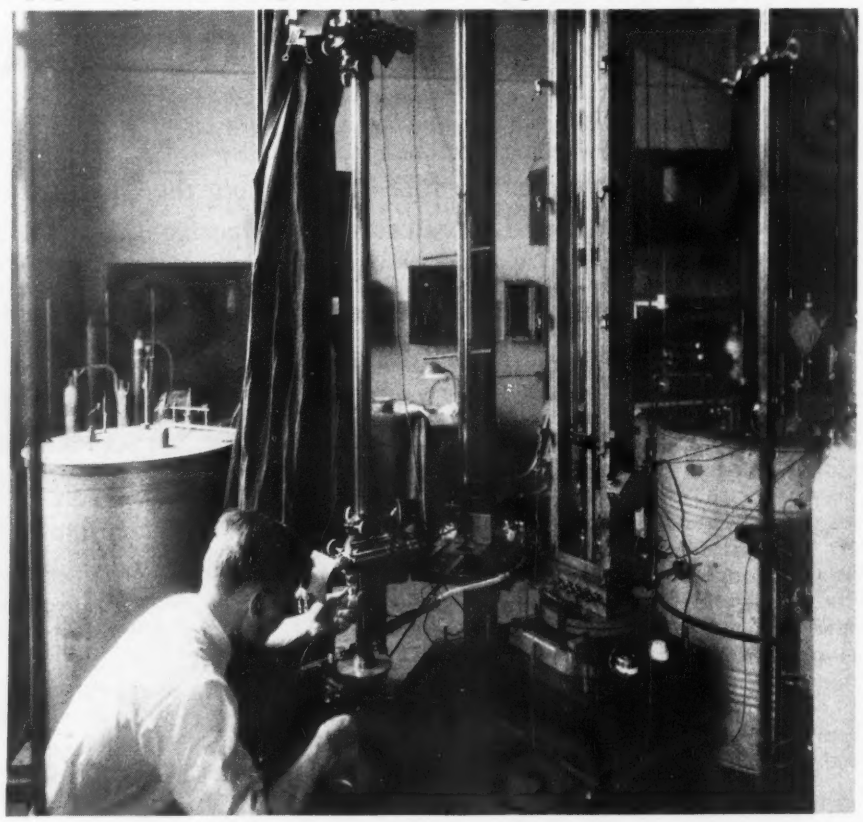
Since $\gamma$ varies with $x$, we must use a trial and error solution, first assuming $x$, and finding $\gamma$ in the fugacity charts. This yields as an answer $x=.65$, which is equivalent to a 38.2 per cent yield.

In the foregoing we see that the only experimental data required were $\Delta H$ at some temperature and the relationship between $C_p$ and $T$ for the reactants and products.

This particular synthesis has been excellently and quite accurately treated by thermodynamic methods. These methods can be used in many cases where the number of side reactions are small in extent and thus do not waste much of the reactants.

For a complete analysis of the problem we would require data on the rate of reaction, for then we could predict the length of time needed to bring the reaction to equilibrium. Thermodynamics gives us no clue as to the speed of the reaction.

*Equipment for measuring thermodynamic temperatures at M. I. T.*



## MAIN STREET'S RAINBOW *glows at night*

The glow that brightens night-time Main Street owes its sparkle and brilliance to rare gases that exist in the air we breathe. Neon, argon, krypton and helium used in so-called "neon-tube" signs create a range of colors that pale the rainbow—a brilliance that vies with the sun.

These and other gases and equipment for their use—products of Air Reduction—contribute in countless ways to the comfort and convenience of daily life .... from anesthesia to aircraft construction .... from sign-lighting to ship-building.

*The operating subsidiaries of Air Reduction Company, Inc., are:*

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*60 East 42nd Street, New York 17, N. Y.*

## THE NITROPARAFFINS

(*Continued from page 42*)

one step beyond the alcohol stage; that is, dehydration occurs. Outstanding examples of these dehydrations are the formation of $\beta$-nitrostyrene from benzaldehyde and nitromethane and the olefin from cyclopentanone and nitromethane. A base is used as a catalyst. The former reaction involving dinitroparaffins is not too widely accepted as absolute fact, but it would be interesting to postulate a mechanism for this reaction or why water should be removed between two molecules and a dinitroparaffin formed. Heim stated in the literature that aldehydes could be converted into dinitroparaffins by an analogous procedure.

Dinitroparaffins may be prepared by treating secondary nitroparaffins with 1 mole of alkali and 0.5 mole of halogen.

$$R_2CHNO_2 + NaOH \rightarrow R_2C{=}NO_2Na + H_2O$$
$$R_2C{=}NO_2Na + Cl_2 \rightarrow R_2C(Cl)NO_2 + NaCl$$
$$R_2C(Cl)NO_2 + R_2C{=}NO_2Na \rightarrow R_2C(NO_2)-CR_2(NO_2) + NaCl$$

Using extremely pure 2-nitropropane and bromine as the halogen, an eighty per cent yield of 2, 3-Dinitro-2, 3-dimethyl-butane is obtained. Primary nitroparaffins do not undergo this reaction, and indeed, lower the yield obtainable from a secondary nitroparaffin when present in small amounts.

There are other synthetic methods for preparing these compounds, but classification would show that even some of the above reactions are really part of a study of the reactions of the nitroparaffins. An article covering this phase of the subject may appear at a later date. Meanwhile, it would be worthwhile to consider the synthetic method, direct nitration, which has been used most in modern times.

In 1880, Beilstein and Kurbatov observed that certain fractions of Caucasian petroleum were readily nitrated. This was the first direct nitration of a saturated hydrocarbon in the liquid phase. A large number of articles were written on this and related topics. The general principles that have become apparent are:

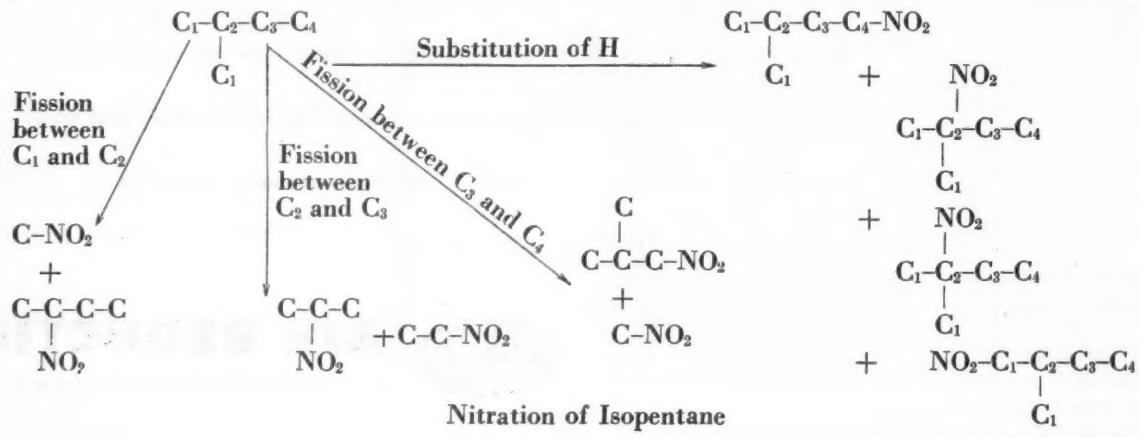
When hydrocarbons are reacted with nitric acid, the replacement of a particular hydrogen atom depends on its structural placement. The order of activity has been found as: tertiary more active than secondary, and secondary more active than primary hydrogens.

| | Nitromethane | Nitroethane | 1-Nitropropane | 2-Nitropropane |
|---|---|---|---|---|
| FORMULA | $CH_3NO_2$ | $CH_3CH_2NO_2$ | $CH_3CH_2CH_2NO_2$ | $CH_3CHNO_2CH_3$ |
| Molecular Weight | 61.04 | 75.07 | 89.09 | 89.09 |
| Specific Gravity at $\frac{20°}{20°}$C | 1.139 | 1.052 | 1.003 | 0.992 |
| Pounds per U. S. Gallon at 20°C | 9.48 | 8.75 | 8.35 | 8.24 |
| Melting Point, °C | −29 | −90 | −108 | −93 |
| Boiling Point, °C | 101.2 | 114.0 | 131.6 | 120.3 |
| Flash Point, °F (Tag open cup) | 112 | 106 | 120 | 103 |
| Vapor Pressure, mm at 20°C | 27.8 | 15.6 | 7.5 | 12.9 |
| Surface Tension, dynes per cm at 20°C | 37.0 | 31.3 | 30.0 | 30.0 |
| Refractive Index at 20°C | 1.3818 | 1.3916 | 1.4015 | 1.3941 |
| pH 0.01M Aqueous Solution at 25°C | 6.4 | 6.0 | 6.0 | 6.2 |
| Rate of Evaporation, by wt. (n-Butyl Acetate = 100) | 180 | 145 | 100 | 124 |
| Solubility at 20°C | | | | |
| ml Solvent in 100 ml Water | 9.5 | 4.5 | 1.4 | 1.7 |
| ml Water in 100 ml Solvent | 2.2 | 0.9 | 0.5 | 0.6 |

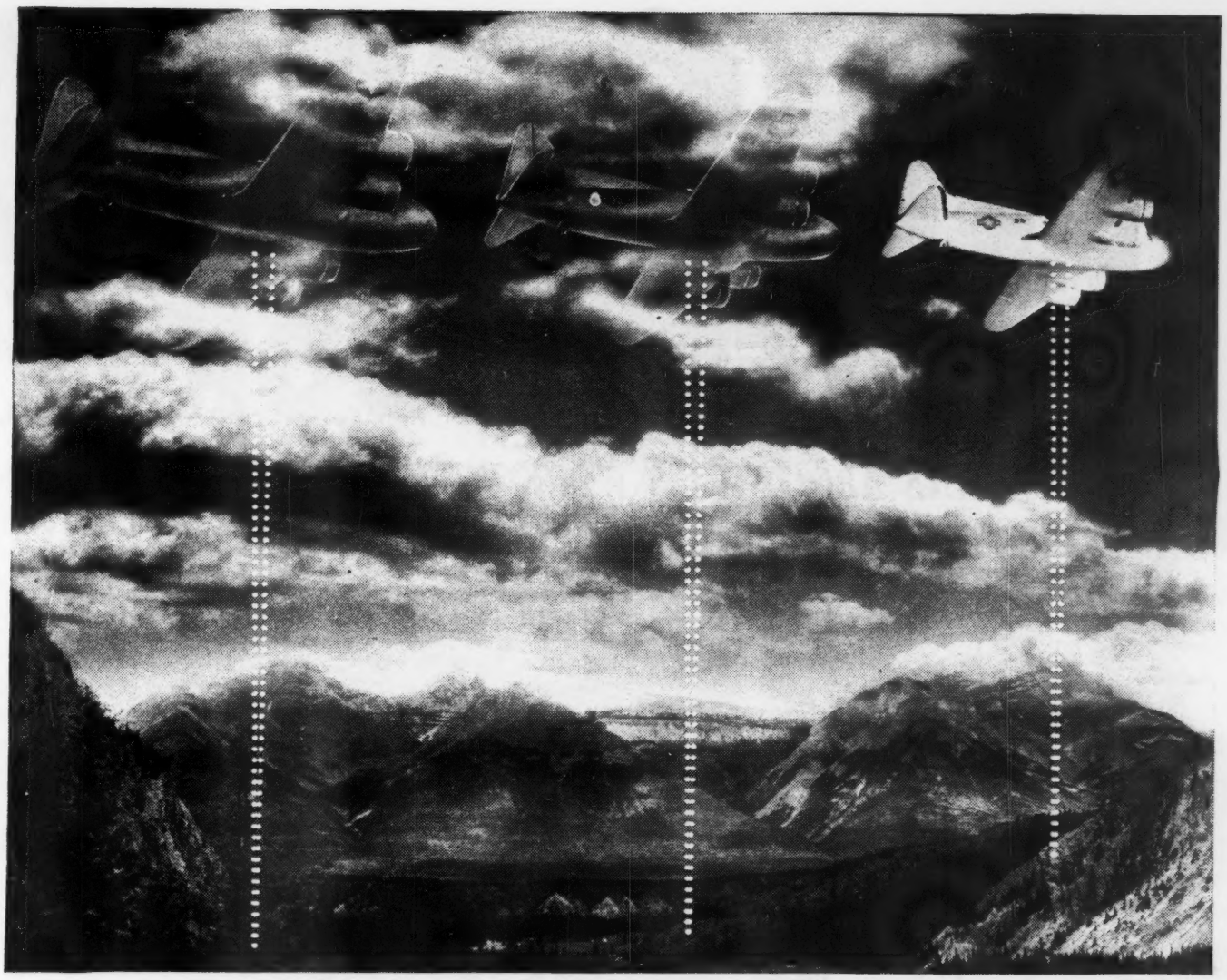
In the liquid phase, reaction is slow and actual yields are somewhat proportional to an increase in the temperature. Up to a point, yield is increased by an increase in the temperature, but then oxidative side-reactions begin to operate so as to oxidize rather than nitrate the hydrocarbon under treatment. Dilute nitric acid at a high temperature in a sealed tube was found to favor the nitration process. Polynitro compounds are formed in great abundance because of the fact that the acid and hydrocarbon are immiscible and the nitro compound finally resulting when the nitration does take place, is more soluble in the acid, and is further nitrated, oxidized, or hydrolyzed.

The sulfuric-nitric mixture known as "mixed acid" is unsuitable for nitrating aliphatic and other saturated hydrocarbons for two reasons. One, the sulfuric acid decreases the small factor of miscibility which exists between the nitric acid and the hydrocarbons and two, it hydrolyzes nitroparaffins quickly, especially when hot.

Recently, it has been found that liquid-phase nitration does not involve free radicals. Haloparaffins can be nitrated as well as hydrocarbons. By heating fuming nitric acid with chloroform under pressure for several hours, a fifty-eight per cent yield of chloropicrin can be obtained. Liquid phase nitration, while giving an insight into chemical processes, does not fulfill the requirements for large scale production. The last method concerns itself with the only commercial method for producing nitroparaffins on a large basis discovered thus far. The general method should prove applicable to other industrial manufactures. (*Continued on page 56*)




Nitration of Isopentane



The RCA Radio Altimeter assures that the last mountains have been passed before letting down to the airport in the valley below.

## *Measuring "every bump on the landscape" —at 20,000 Feet!*

**A** radio altimeter—that indicates the exact height above land or sea—is another RCA contribution to aviation.

Old-style altimeters gave only the approximate height above sea level—did not warn of unexpected "off-course" mountains.

To perfect a better altimeter was one of science's most baffling problems. So RCA developed an instrument so accurate it "measures every bump on the landscape" from the highest possible altitudes...so sensitive it can measure the height of a house at 500 feet!

This altimeter—actually a form of radar—directs radio waves from the airplane to earth and back again . . . tells the pilot exactly how far he is from the ground...warns of dangerously close clearance . . ."sees" through heaviest fog or snow.

*All* the radio altimeters used in Army, Navy and British aircraft were designed and first produced by RCA. This same pioneering research goes into *every* RCA product. So when you buy an RCA Victor radio, Victrola, television receiver, even a radio tube replacement, you enjoy a unique pride of ownership. For you know it is one of the finest instruments of its kind that science has yet achieved.

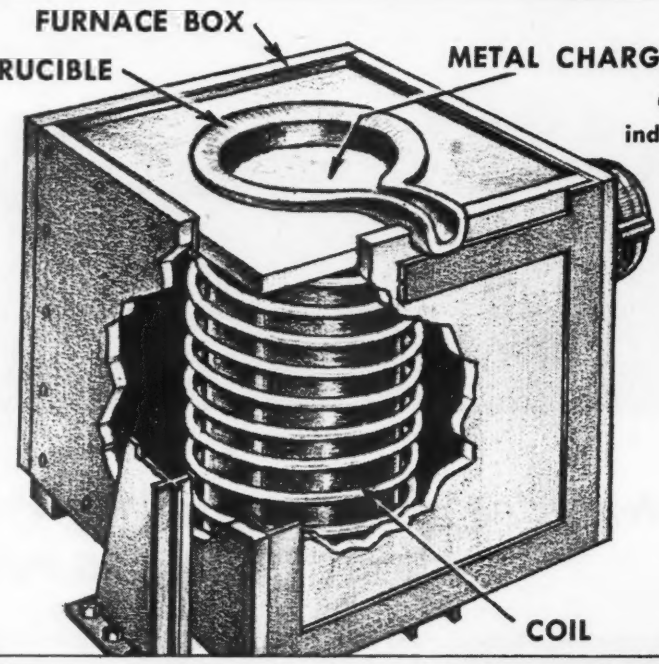
Radio Corporation of America, Radio City, New York 20. *Listen to The RCA Show, Sunday, 4:30 P. M., E. T., over NBC.*

**The RCA radio altimeter** will be a major contribution to the safety of post-war commercial flying. The section at the left sends the radio waves to earth and back again while the "box" at the right—timing these waves to the millionth of a second—tells the navigator the plane's exact height in feet.

RCA **RADIO CORPORATION of AMERICA**

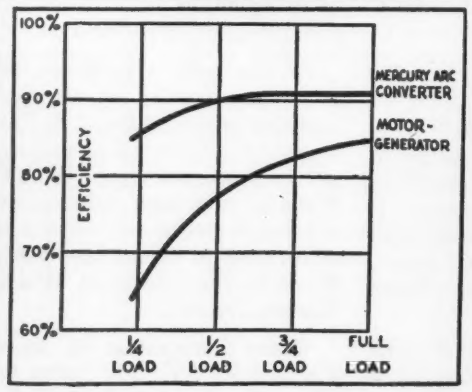
# HI-SPEED
# "FIRELESS COOKER"

*NEW FACTS ABOUT A-C'S WORK WITH INDUCTION HEATING—*
*ANOTHER TEST OF OUR ABILITY TO SOLVE PROBLEMS IN ANY FIELD*

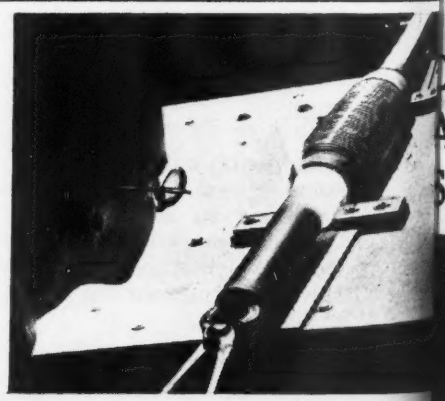



**Inside view of Induction Furnace showing important application of Industry's newest electronic tool—Allis-Chalmers Mercury Arc Converter which supplies essential high-frequency current to induction heating coil.**

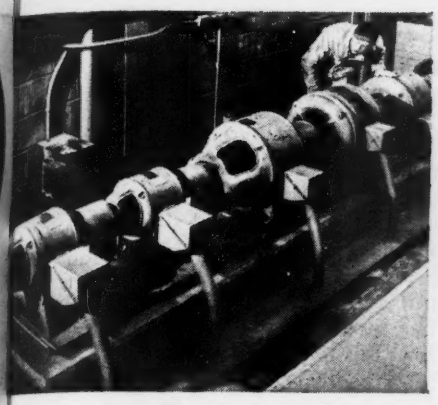
**1** Today—already applied to induction furnaces, producing the energy that makes metals melt in their own heat with great savings of time and power — is an amazing electronic device made by A-C!



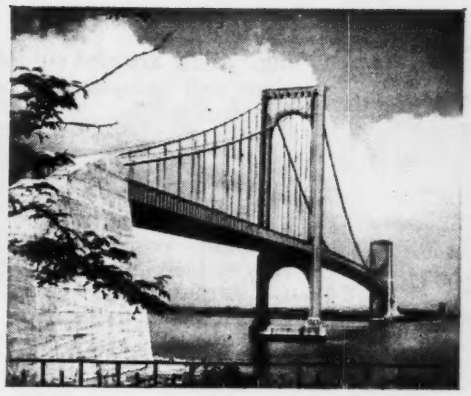

**2** First applied to induction heating by Allis-Chalmers, the Mercury Arc Converter has proved superior in many ways to conventional rotating equipment—for instance *steps up efficiency 6 to 12%* (see graph).



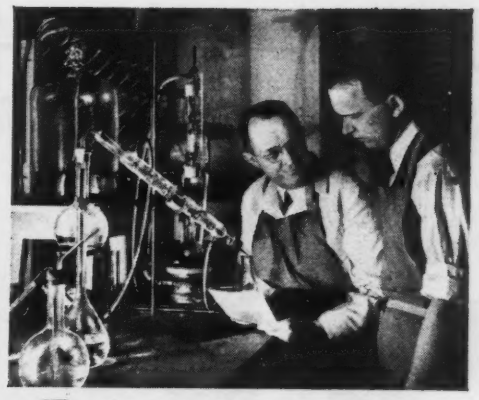
**3** Other advantages of the Converter and induction heating: clean, flexible, easy to operate and control. Engineers predict for the future many new industrial possibilities in widely divergent fields!



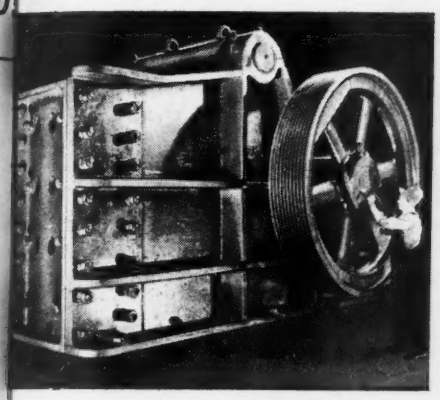
4 In other industrial fields, A-C engineering has been equally alert. To balance and control power accurately for special steel mill operations, we developed the "Regulex" Exciter Set, above.



5 The "Regulex" Control helps speed output of steel wire for bridge cables . . . regulates electrode position in electric furnaces—means extra "heats," more special alloy steel for peacetime use!

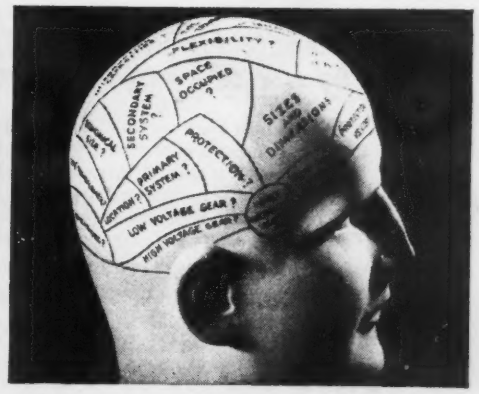


6 Wherever chemicals are processed for drugs, plastics, synthetic rubber, you're apt to find other important A-C developments at work —special pumps, sifters, scrubbers and rotary kilns.



7 The same is true of the mining and cement making fields. We outfit entire processing plants — make the world's most complete line of crushers, grinders, screens and other basic industry equipment.

8 Our new techniques, learned in war, will work for better peacetime living! Postwar homes, cars, food, clothing—*all* will be made faster, cheaper *and better* thanks to A-C "know-how" in many fields.




9 What's your technical problem? Our staff of experts can assist your engineers . . . offer careful, skilled analysis—new machines and methods to help speed output, meet keen competition. Call us.

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin

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**Draw on our Vast Experience for Help in Solving Manufacturing and Assembly problems. We offer any industry Cooperative Engineering Service—the World's widest Range of Major Industrial Equipment!**

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PRODUCER OF THE WORLD'S LARGEST LINE OF MAJOR INDUSTRIAL EQUIPMENT

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Engineering That Aids All Industry, and Furthers American Good Living.

*Simplifying Open Wire Circuits by use of Cable Sections*

• Engineering students will be interested in Okonite's research publication on the use and advantages of insulated wire and cable as sections of open wire circuits. Bulletin OK-1019 is available on request. Write to The Okonite Company, Passaic, New Jersey

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INSULATED WIRES AND CABLES
3721

## THIS IS M.I.T. — METEOROLOGY

(*Continued from page 37*)

study the problem effectively in the laboratory. The atmosphere is our only laboratory and since the variables cannot be controlled, recourse must often be made to statistical analyses. In spite of the present limitations of the theoretical attack, many useful results have been obtained this way and it appears that future improvements will come largely as a result of the expansion of the theoretical and physical approach. In the meantime, since forecasts must be made, it is necessary to rely heavily on empirical methods.

The instruction in meteorology emphasizes the physical and theoretical background but also includes a considerable amount of descriptive and empirical material. A large amount of time is devoted to the analysis of current weather data and the preparation of forecasts. The first two years of the undergraduate curriculum are practically the same as in the other engineering and science curricula in order to provide a sound background in mathematics and physics. The meteorology subjects first appear in the third year accompanied by subjects in engineering thermodynamics, fluid mechanics, the humanities, and mathematical statistics. The fourth year is devoted entirely to meteorological subjects. These include dynamic meteorology which is concerned with the theoretical background, descriptive meteorology, synoptic meteorology which bridges the gap between the theory and the forecast, climatology which is concerned with the average weather, and synoptic meteorology in which all subjects are applied to the practical job of forecasting. There are also subjects in meteorological observations and instruments, oceanography, and physics of the atmosphere.

Before the war, the chief employers of meteorologists were the Weather Bureau and the airlines. There is little doubt that these organizations will require more meteorologists after the war. However, many of the available positions will be filled by men who have received training and experience in the military services. The great opportunity for expansion of the meteorological profession lies in the field of industrial meteorology. There are few businesses or industries whose operations are not affected in some way by the weather. In some cases the relationships are obvious and are being capitalized on. In most cases the connection is more obscure and has not been investigated. Establishment of such relationships requires complete knowledge not only of meteorology, but also of the particular business or industry. For this reason, such studies cannot be undertaken by a governmental agency such as the Weather Bureau, but must be carried out by private meteorologists working either as full-time employees or as consultants. A few such investigations have been undertaken and have proven very profitable. The potentialities of this type of work are tremendous but much still remains to be done to convince industry and business of the importance of the weather factor in their undertakings.

Many types of positions are open to the meteorologist besides short-range weather forecasting (up to forty-eight hours). Some of these are long-range forecasting, instrument development and design, climatological work, teaching, research, industrial meteorology, hydrology, oceanography; studies of the weather factor in airport design, drainage, flood control, road building, construction of all types, air conditioning, agriculture, and the control of smoke and industrial pollution.

One of the interesting features of meteorology is its youth as a science. We have barely made a start in understanding the atmosphere. This means that a capable man can rather quickly acquire sufficient knowledge to take him to the boundaries of our knowledge. Once there, the opportunities are so great that even the ordinary individual can look forward to making important contributions if he perseveres. Further knowledge of meteorology which will permit more accurate and longer range forecasts to be made will contribute greatly to the economic life of the nation.

## THE NITROPARAFFINS

(*Continued from page 52*)

"When a paraffin is nitrated in the vapor phase at high temperatures all of the mononitro substitution products are obtained which could result if we conceive of the nitro group as capable of substituting either any hydrogen atom or any alkyl radical present in the hydrocarbon." A scheme for the vapor-phase nitration of isopentane illustrates this principle rather well.

Temperatures of nitration range from 248° C. to 600°+ C., but the interval between 400–450° C. has been found most suitable. The use of pressure also facilitates the process. Dr. Hass, at Purdue Research Foundation, found that when nitration was conducted in the vapor stage, it proceeded in a controllable and economical manner.

(*Continued on page 58*)

## THE BATTLE DONE?

(*Continued from page 48*)

the only reason for their defeat was that we discovered the secret of atomic power first, denying any other superiority of the United States over Japan in men, material, or leadership. There was an openly implied threat that when Japan too learned that secret they would have another try at us on more equal terms. This sort of talk quieted down very soon, upon imperial order probably, but may be taken as a general indication of what the real feeling is among our defeated foe.

Japan had not suffered the humiliation of an armed invasion; much of her "stolen empire" was still under her control when the surrender order came; her war leaders were still very much alive; she had large, well-equipped armies in China and Manchuria as yet untouched by the war; and her over-all capacity for waging war was *not* exhausted. All this is in contrast to the condition of Germany after the final fall of Berlin.

The Japanese do not realize they were defeated and view the peace as "a temporary recess ordered by the Emperor." About those untouched thousands of Japanese soldiers from Java to the Russian border, they have been described as having had "three years of victory capped by a surrender order stating that the Emperor had graciously decided to end the war," which is a rather good summary of the situation.

But Japan, with far more reason than Germany to feel capable of defying our rule, has not shown that same haughty arrogance which marks the attitude of the German people. Rather they are politely obsequious in defeat, at least since those first days. The reason: Germany is beaten and has nothing left but sullen defiance; Japan still hopes.

Again after much criticism of all sorts in the press, our Government finally issued a statement of its occupation policies in Japan. If this is strictly enforced, Japan's power to make war should be permanently crushed. It is up to us, the American people, to ensure that our enemies will not again menace our civilization because we neglected to do a really thorough job at winning our war, and to support a strict military occupation of Japan and Germany so long as our military leaders deem it necessary, in order that eventually they too may become useful members of the United Nations.

S. L. S.


S.S.WHITE FLEXIBLE SHAFTS

IN THE ENGINEERING PICTURE

S.S.White flexible shafts are basic mechanical elements for transmitting power and for remote control under conditions which do not permit of direct connection with solid shafts. As such, their place in engineering is well established and important. This is indicated by the millions of feet taken annually by applications in aircraft, motor vehicles, machinery, portable tools, radio and other electronic equipment and many other products.

The reasons for this wide-scale use are the advantages offered by these **"metal muscles"** for many power drive and remote control uses. Consider the following fundamental facts:

1. With a single S.S.White flexible shaft you can transmit power or provide remote control between any two points, regardless of the relative locations of the points or of the distance or obstacles between. This single-part simplicity, in contrast with systems of gears, universal joints, belts and pulleys, etc., means simplified manufacturing and assembly, reduced production time and costs.

2. The use of S.S.White flexible shafts often makes possible product improvement because it gives unrestricted freedom in placing driving and driven or controlled members wherever desirable to secure highest efficiency, ready assembly, space saving, convenience of operation and servicing.

**SEND FOR THIS FREE BULLETIN**

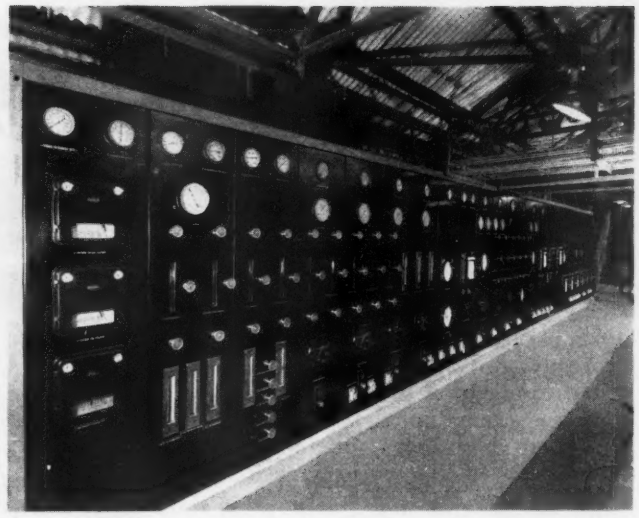
A knowledge of S. S. White flexible shafts and their power drive and remote control possibilities will be helpful to you as an engineer. *BULLETIN 4501* will give you the basic facts and technical data. A copy is yours for the asking. Please mention your college and course when you write.

## THE NITROPARAFFINS

(*Continued from page 56*)

The nitric acid is boiled off and the vapor heated to about 400° C. in a gas-fired furnace. Then, propane gas (or some other hydrocarbon gas) at 10 atmospheres pressure is passed in. An exothermic reaction takes place almost immediately, and in order to prevent oxidation and waste of material, the process is allowed to go on to the most valuable point from a business viewpoint. The physical conditions under which the nitration is carried on, affect greatly the amounts and costs of products. In the commercial plant, temperatures are controlled within ±1° F. The gases from the furnace are passed through a heat-exchanger and a condensing system. The various gases are separated, the nitrogen oxides being reconverted back to nitric acid, and the others being disposed of. The liquid components are washed free of acid and steam distilled. The nitroparaffins which are carried over with the water are separated by decantation and fractionally distilled through a huge column. From the nitration of propane, the hydrocarbon being used at present in the commercial plant, four products are separated: (1) nitromethane, (2) nitroethane, (3) 1-nitropropane, (4) 2-nitropropane. These are refractionated to give the fairly pure nitroparaffin, whose properties are shown in the accompanying table.

The nitroparaffins are finding wide use, both directly and through their derivatives, in industry. These new industrial products have set the pace for the chemical industry in postwar America and it is a fast and furious pace that they have set! A forthcoming article will describe the chemical properties, reactions, and uses of the nitroparaffins.



*Only two men are required to operate the control board for the entire plant*

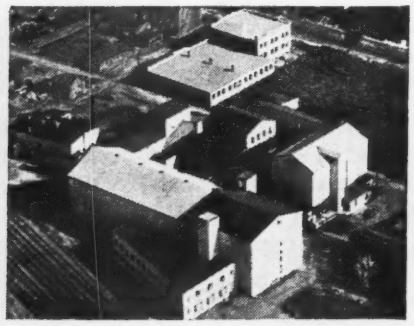
Ice Service

Ageing Meats

Locker Service

Freezing & Boxing Foods

Frozen Food Storage



**Another Highly Successful Community Refrigeration Center**

The Consumers Ice and Coal Co., Lancaster, Penna., provides refrigeration service to some 2500 customers. The plant produces 90 tons of ice daily, serves town and country routes, and ices refrigerator cars; but ice comprises only one-fifth of its business. • Its locker system is complete with processing equipment, chilling and ageing rooms, quick-freezer, and 2200 food compartments; has 3 sub-stations in nearby towns. • Thousands of pounds of locally grown fruits and vegetables are cleaned, graded, quick-frozen, packaged, and sold under the "Consumers" label, each season. Four Blizzard freezers handle this load. Six freezer storage rooms hold 3 million lb. of various frozen foods. • Fresh fruits (up to 75,000 bushels) are stored, not to mention carloads of such products as cheese, cream, cabbage, meats, potatoes, etc. • Frick refrigerating, ice-making, quick-freezing, and cold-storage equipment is used throughout. • A similar COMMUNITY and REFRIGERATION CENTER could be of great service to YOUR town.

FRICK CO. Waynesboro Pennsylvania

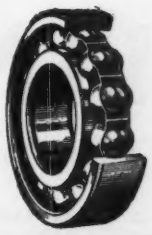
**WIRES and CABLES**
for every electrical purpose
**CONDUITS—RACEWAYS**
Moldings, Underfloor Duct,
Steel, Non-Metallic
*A raceway for every wiring system*

**BUT** **Hiroshima, where millions of ball bearings were stock-piled, was target for the first atomic bomb in history.**

**AND** **Schweinfurt and the other Nazi ball bearing centers were primary objectives of our bombers in Europe.**

Yes, the heart of *any* nation's industrial might is the ball bearing.

Nothing rolls like a ball. It is nature's favorite, strongest form. Thus, the *ball* bearing is a "natural" for the higher speeds, heavier loads and greater rigidity demanded by today's exacting production standards.



When designing your new machines, take advantage of the creative engineering, technical skill, long experience and precision manufacturing methods of New Departure—the world's greatest maker of ball bearings.

**NEW DEPARTURE**
**BALL BEARINGS**

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NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN • Branches in DETROIT • CHICAGO • LOS ANGELES and other Principal Cities

THAT ROEBLING WOVEN WIRE SCREEN ALWAYS PANS OUT DOESN'T IT?
THAT'S RIGHT, AND I HEAR THEY MAKE JUST AS GOOD WIRE ROPE, ELECTRICAL WIRES AND CABLES, STRIP STEEL, AND FLAT, ROUND AND SHAPED WIRE!
JACK MARKOW

Roebling produces every major type of wire and wire product . . . toaster cord to telephone cable . . . bridge cable to wire rope . . . fine filter cloth to heavy grading screen . . . strip steel and flat wire to round and shaped wire . . . all Roebling products. *All* the result of over 100 years of wire specialization.
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WIRE ROPE AND STRAND • FITTINGS • SLINGS • SUSPENSION BRIDGES AND CABLES
COLD ROLLED STRIP • HIGH AND LOW CARBON ACID AND BASIC OPEN HEARTH STEELS
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## ALUMNUS OF THE MONTH

(*Continued from page 45*)

Traffic Control, under the chairmanship of Professor J. A. Stratton. In setting up the Loran system on a world-wide basis Fink traveled seventy-five thousand miles by air from Darwin to Cairo. On his return to *Electronics*, at the end of the war, he was appointed Executive Editor, which post he now holds.

The electronic interest has penetrated leisure hours as well. He operates his amateur station regularly, has recorded an extensive collection of Bach played by his father, a leading organist, and has designed and built a television receiver for his home. For outdoor activity he has a twenty-foot auxiliary sloop on the Potomac, now waiting to be sailed around to the Hudson, and a pair of skis in storage at Cranmore.

## LIGHT CUT TO ORDER

(*Continued from page 36*)

The phenomenon is due to the cellophane absorbing some of the wave lengths of light after this light has passed through the first polarizing plate. This causes the light to become colored. Many interesting effects can be accomplished in this manner.

This apparatus finds its greatest use in advertising and exhibition displays.

Color due to polarized light is used in microscopy. Polarizing filters in microscopes aid in the study of objects because of the refracting properties of different parts of some objects. Light from these parts when polarized shows up sections and physical characteristics much better than any other methods.

Strains are studied by this technique. Normally isotropic substances change crystalline structure under strain to become double refracting. The strain varies with the amount of double refraction. In this manner the characteristics that an object should have as composition and construction can be determined.

Just a few applications have been presented. There are hundreds of others, but those examples given are sufficient to show the value of polarized light.

In its short history the control of polarized light has become highly important although its ultimate possibilities have not yet begun to be realized.

# 317,996 Pieces of Mail in a Single Day

*pass through these offices . . .*

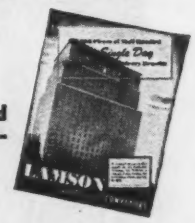
# VIA LAMSON CONVEYORS

Lamson designed this system for the Prudential Insurance Co. Without a change, it now handles the tremendous volume required by the O.D.B.

9,000 employees—servicing 7,216,310 active accounts for dependents of Army men and women. 360,000 "Status Changes" in an average month—9,700,000 to date. To handle these staggering totals the Office of Dependency Benefits, in the Newark, N. J. building designed for the Prudential Insurance Co., handles a mail volume that reaches a crescendo of 317,996 pieces in a single day. The routing and delivering of messages alone formerly required 150 messengers.

The function of these messengers, expending 1,200 man-hours every day, is now filled by only *three* Lamson Vertical Conveyors. Elevator congestion is gone—pushcarts no longer clog hallways—the risk of human error, fatigue-inspired, has been removed. One of America's most difficult office jobs is better performed, because of the ingenuity of Lamson Engineers who installed this system for Prudential.

**A special folder illustrates and describes this amazing installation. Write for your copy!**



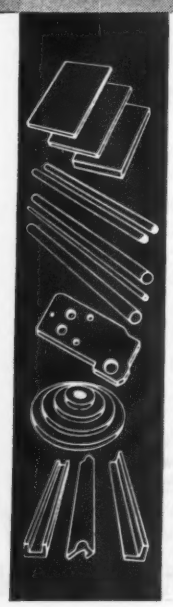

## LAMSON CORPORATION

*Makers of Conveyors and Tubes*

**950 LAMSON ST., SYRACUSE 1, N. Y.**

From the Metro-Goldwyn-Mayer picture MADAME CURIE

# They Pried Open a Great Door



SHEETS

RODS

TUBES

FABRICATED PARTS

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THE dramatic quest of Madame and Pierre Curie ended not only in the historic discovery of radium but opened a great door leading to new concepts of matter and therapy.

A similar, but less arduous, quest by you in relation to technical plastics might open a door to valuable possibilities. Practical and profitable new uses for these technical kinds of plastics are imminent, awaiting investigation and trial.

One sound approach to your application is to check over your requirements with us. Should a material with excellent electrical properties and resistance to corrosion, mechanically strong and easy to machine be indicated, our type of technical plastics, Synthane, may fill the bill. Our complete catalog, free for the asking, will be helpful to you. Synthane Corporation, Oaks, Pa.

**SYNTHANE TECHNICAL PLASTICS**

SHEETS • RODS • TUBES • FABRICATED PARTS **SYNTHANE** MOLDED-LAMINATED • MOLDED-MACERATED

***Plan your present and future products with Synthane Technical Plastics***

# *Gas* AND THE
# Business Men of Tomorrow

THERE is hardly an industrial or commercial establishment that does not use heat in some form—whether it be a bakery or a restaurant, a foundry or glass plant. When the energetic, forward-looking men who have planted our banners on the ruined pillboxes of the enemy return to take their places in our industrial and commercial life, they will find that one factor in modern production comes readily within reach of those with modest capital—that is Gas equipment for the application of heat.

True, there are giant Gas furnaces that represent substantial investment, engineered to do big jobs in a big way. But there are types of Gas equipment to fit every need—from the biggest to the smallest. That is one of the many advantages of Gas and Gas equipment—flexibility. Here is a fuel and a method of application that meets every need for industrial and commercial heat. It meets them economically, too, affording unit and overall savings that any business man or industrialist appreciates.

The Industrial Engineers and Commercial Representatives of local Gas Companies will be glad to discuss with these new industrialists and business men the advantages of modern Gas equipment and advise them in the choice of specific equipment.

**American Gas Association**
Industrial and Commercial Gas Section
420 Lexington Avenue New York 17, N. Y.

THE TREND IS TO GAS
FOR ALL INDUSTRIAL HEATING

SKF bearings are used in the machinery which creates the hurricanes in this wind tunnel for testing planes at Langley Field, Virginia. The tunnel uses 8,000 horsepower electric motors.

**"SHOOTING THE BREEZE"** may be a matter of stirring up a cooling zephyr for summer comfort. Or it may be a 500-mile-per-hour hurricane to test planes in the wind tunnel at Langley Field.

In either operation, there is mechanical motion at high speed — with a need for anti-friction bearings, carefully designed for a specific task.

Different loads, speeds and other factors require bearings of different kinds. Therefore, SKF makes both ball and roller bearings — from small ones for tiny motors and appliances up to huge bearings used in the largest motors and locomotives.

Because so many SKF bearings have gone into fighting ships, tanks, planes and other war equipment, you may have been unable to get all the SKF bearings you need. But before very long, we hope, SKF and its distributors will again offer you prompt service on the complete SKF line. SKF recommendations are always unbiased because we know the importance of *the right bearing in the right place.*

SKF INDUSTRIES, INC., PHILA., PA.

# Lady Macbeth needed an electric washing machine

LADY MACBETH was the original lather lady! She hated spots. A "Damned Spot" . . . to be exact. In fact it was a tell-tale spot of blood that caused her downfall, according to Will Shakespeare, the w.k. Bard of Avon. All Lady Macbeth needed was some peroxide, cold water and an electric washing machine . . . to change her destiny.

All the various elements of an electric washing machine, yes, even all the aluminum was on earth when Lady Macbeth delivered her famous soliloquy to the bleak Scottish moors . . . but the best kilted necromancers of her Highland Court lacked the "know-how" to imagineer them.

We invented the word "Imagineering"* to describe how Alcoa, and other great groups of technicians go about the job of supplying the methods, materials and machines of modern life.

Today . . . Youth laments that there are no new lands to discover, no new frontiers to cross. And yet, in the uncharted kingdom of the mind, hardy pioneers are daily spanning new horizons in the twin fields of invention and adaptation. Aluminum offers exciting new opportunities to every intrepid Imagineer . . . who seeks new industrial worlds to conquer.

ALUMINUM COMPANY OF AMERICA

Gulf Building, Pittsburgh 19, Pa.

*Imagineering equals the union of imagination, man's oldest mental development, and engineering his newest. Together they are the key to progress.

ALCOA FIRST IN ALUMINUM

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# GE CAMPUS NEWS

RESEARCH AND ENGINEERING KEEP GENERAL ELECTRIC YEARS AHEAD

## A NEW "HOUSE OF MAGIC" FOR PEACETIME AMERICA

*"Many things have been discovered during this war, and we can and must develop them into better things for peacetime.*

*"Today we have 550 research people on our staff. New facilities will not only give increased outlet for their abilities, but will provide opportunities for new research minds with new talents.*

*". . . even more than in the past the laboratory will emphasize research in pure science—continuing and expanding the work begun by Dr. Whitney and the late Dr. Steinmetz forty-five years ago."*

**C. E. Wilson**
*President, General Electric Company*

### A New Idea

In 1900 Dr. Steinmetz, Elihu Thomson, A. G. Davis, and E. W. Rice, Jr. originated the idea of a laboratory that would be devoted to the problems of fundamental research, without immediate concern for commercial results.

Up to then fundamental research in this country—what there was of it—had been largely left to colleges. In 1900 industrial laboratories had not grown beyond the status of "trouble stations" maintained only for the immediate needs of the factories.

They started the G-E Research Laboratory from scratch—in a barn behind the Steinmetz home—a far cry from the $8,000,000 laboratory building planned for peacetime America.

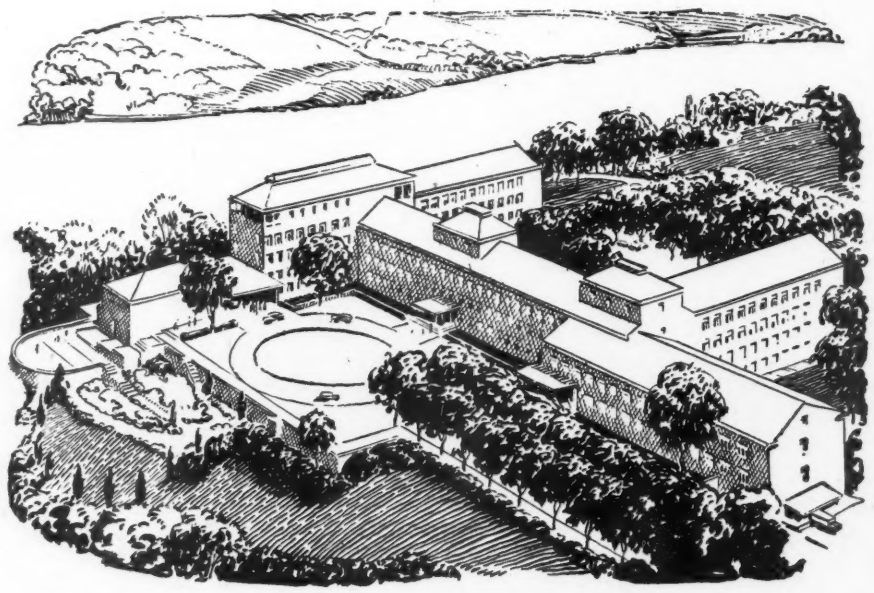
Years of research and engineering have built the laboratory into a veritable "House of Magic." It meant the work and ideas of men like Dr. W. R. Whitney, Dr. W. D. Coolidge and Dr. Irving Langmuir. In 1914 the laboratory moved to a new brick structure—then the last word in laboratory construction. Research had come into its own.

The laboratory will now move to a more spacious location. Plans have been approved, the site has been chosen, and it is hoped that construction can start within six months. The site, five miles east of Schenectady, offers special advantages for a "House of Magic" of the future. On a rocky cliff near the Mohawk River, it's particularly adaptable to General Electric's work with radar, television, high-frequency, jet engines, and x-ray.

### Research Staff Will Grow

An expanded staff will carry on this research in a laboratory built on a 219-acre estate. Looking ahead 15—or even 20 years—still further expansion may be required, such as smaller structures for special purposes, and a pilot plant for new chemical processes. All this requires not only a building that is immediately suitable, but one with grounds around it for other buildings.

But the ideas evolved in this new laboratory will not be the ultimate in research. The word *research* implies a continuing process. It is unlikely that the physicists, chemists, and engineers of our country will ever stop prying into the secrets of fundamental science. In the words of Dr. Coolidge, "A research laboratory is essentially a group of men in a congenial atmosphere, engaged in *extending* the frontiers of knowledge." *General Electric Company, Schenectady, New York.*



This new building—as an artist sees it—will be from two to five stories in height and will include 300,000 square feet of laboratory working space.

In the past forty-five years G.E. has contributed to better living in America—not only through new developments in electricity, metallurgy, electronics, and chemistry, but also through reduced cost and increased efficiency, as in the modern incandescent lamp. In 1923 a 60-watt lamp cost 40 cents. Today the 60-watt bulb gives 50% more light for the same current and costs only 10 cents, plus tax—thanks to G-E research.

**The best investment in the world is in your country's future. Keep all the Bonds you Buy.**

**GENERAL ELECTRIC**

The Murray Printing Company
Cambridge, Massachusetts